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New York State Education Department
Science Division, February 23, 1912

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I have the honor to transmit herewith for publication as a bulletin of the State Museum, the annual report of the Director of the Science Division for the fiscal year ending September 30, 1911.

Very respectfully
JOHN M. CLARKE
Director

STATE OF NEW YORK
EDUCATION DEPARTMENT
COMMISSIONER'S ROOM

Approved for publication this 24th day of February 1912

A. S. Draper

Commissioner of Education

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National Museum.

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JOHN M. CLARKE

Director State Museum and
State Geologist

STATE HALL, ALBANY, N. Y.

Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 516 ALBANY, N. Y. APRIL 1, 1912

New York State Museum

JOHN M. CLARKE, Director

Museum Bulletin 158

EIGHTH REPORT OF THE DIRECTOR OF THE SCIENCE DIVISION

INCLUDING THE

65th REPORT OF THE STATE MUSEUM, THE 31st REPORT OF THE STATE GEOLOGIST, AND THE REPORT OF THE STATE PALEONTOLOGIST FOR 1911

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INTRODUCTION

This report covers all divisions of the scientific work under the charge of the Education Department and concerns the progress made therein during the fiscal year 1910–11. It constitutes the 65th annual report of the State Museum and is introductory to all the scientific memoirs, bulletins and other publications issued from this office during the year mentioned.

Under the action of the Regents of the University (April 26, 1904) the work of the Science Division is "under the immediate supervision of the Commissioner of Education," and the advisory committee of the Board of Regents of the University having the affairs of this division in charge are the Honorables: T. Guilford Smith LL.D., Buffalo; Daniel Beach LL.D., Watkins; Lucian L. Shedden LL.D., Plattsburg.

The subjects to be presented in this report are considered under the following chapters:

I Condition of the Scientific Collections
II Report on the Geological Survey
III Report of the State Botanist

IV Report of the State Entomologist
V Report on the Zoology section
VI Report on the Archeology section
VII Publications of the year
VIII Staff of the Science Division and State Museum
IX Accessions to the collections
X Appendixes (to be continued in subsequent volumes). All the scientific publications of the year

I

CONDITION OF THE SCIENTIFIC COLLECTIONS

During the year past the preparations for moving the collections into the Education Building have taken precedence over most other activities of the staff of the Museum. The collection rooms in Geological Hall have been closed to the public and at the present time the scientific materials are for the most part ready for removal. It became necessary early in the year to transfer all the stored material and publications of the Museum from the McCredie malthouse which has been in use many years as a storehouse, to their present quarters, the old Taylor brewery, in a distant part of the city, and to the latter place additions to the collections are at present being removed as they come in. In the installation of the collections in the Education Building all this material will come into requisition. There still remains in other buildings very much valuable material as indicated in my previous reports (see report for 1909–10).

The fire of March 29, 1911, which destroyed the west end of the Capitol and the State Library, involved the State Museum in very serious loss. On the landing at the head of the western stairway and along the corridors leading thereto the archeological collections were arranged. These were the historic Indian collections of costumes and implements which had been brought together during the existence of the institution. They contained materials gathered by Schoolcraft, Lewis H. Morgan and others in the early days when the Regents of the University gave special encouragement to the study of aboriginal life and records; and many later collections obtained by purchase or gift. As a whole the exhibit there arranged was the most complete assemblage of Iroquois materials in existence and because of its great scientific value, it had been removed from Geological Hall to the Capitol for greater safety. It is difficult to estimate the money value in this loss. I have placed it somewhat conventionally at $20,000 which is an approximation to the expenditure that would be necessary to replace the collections,

so far as replacement is possible. Numerically the loss is about 10,000 articles, of which not one-twentieth part, even of the stone implements, was saved. Such statements however take no account of the intrinsic value of the collection to students of ethnology, for these collections were widely known for their excellence and completeness.

The hope of replacing this loss in the quality of the materials destroyed can not be entertained, but there is still a reasonable expectation of making good some part of it by the acquisition of collections now in private hands among the citizens of New York. It is probably true that the last great collections of such culture relics have now been made. To replenish the lost collections from actual excavations is a rather remote chance. What is to be done to repair these collections should be done promptly before the private collections become dispersed as parts of estates.

The director does not mean to convey the impression that all the Indian collections of the Museum were thus destroyed. A goodly part of the more recent acquisitions were in another building at the time of the fire. All the wampum belts of the Iroquois which were received from the Six Nations some ten years ago and some specially notable articles besides were in safety deposit. The life casts and all the appurtenances of the Six Nations groups which are under construction were in other buildings.

The Museum was in a way fortunate in not losing all its scientific collections exposed in the Capitol. In the senate gallery corridor leading to the western stairway were a number of special exhibits, some of recently excavated Indian relics, others of fossil sponges, mineral crystals and pottery. The flames swept by the open end of this corridor taking everything in their path but nothing in the corridor itself was harmed. These cases still remain where they stood before the fire.

On account of the accumulation of the reserve stock of Museum publications it seemed wise at the time of the removal of this stock from one storehouse to another, to undertake a general distribution of the items of which the reserve was needlessly large. This reduction of stock was accomplished without impairing the necessary reserve for future demands and several thousand copies of these publications were thus distributed, for the most part to European libraries.

Valuable accessions to all departments of the Museum have been made during the year. Their character is given under chapter IX of this report.

II

REPORT ON THE GEOLOGICAL SURVEY

SOME PRACTICAL FEATURES OF NEW YORK GEOLOGY[1]

The services which geology may render to industry and technology are becoming widely recognized with the progress of organized survey work, but nowhere in the country perhaps is the relationship more historic or continuous with respect to actual records than in this State. The reports of the First Survey of New York, issued between the years 1837 and 1841, give prominence to the consideration of natural resources; their treatment of the mineral deposits particularly attains a measure of accuracy and comprehensive value that is at least surprising in view of the conditions under which they were prepared. So far as our knowledge goes they represent the earliest attempt to cover the physical features of a whole commonwealth with similar detail and to maintain a practical balance between the twofold objects, pure and applied knowledge, that should be subserved by such investigations.

Since their publication applied geology has gained materially by accumulated experience and improved methods of research. In keeping with the needs of modern industrial activities there has come a demand also for more specialized information than was afforded by the early reports, as well as for the extension of survey work into entirely new fields.

To illustrate more particularly the features of this development we outline briefly some of the later investigations carried out in New York with their purposes and results, making reference at the same time to other possible inquiries that may be followed with profit.

Mining. The relation of geology to mining is of first importance to the State, though New York it would appear is not generally considered to be very largely endowed with mineral resources. This view is justified only with regard to metallic minerals, of which, aside from iron ores, the deposits are neither varied nor specially extensive. But a production valued altogether at nearly $40,000,000 a year on the basis of crude materials is not an inconsiderable item, even when compared with the totals of many so-called mining states. As a matter of fact New York ranks well up in the list and ahead of nearly all states that are similarly lacking in wealth of mineral fuels.

[1] By D. H. Newland.

Some of the most valuable mineral deposits are found within the series of sedimentary or stratified rocks which cover all the area outside of the Adirondacks and the Highlands region. Such deposits generally occur at definite horizons and it has been the task of the geologist to identify their position in the series of rock formations by study of the accompanying evidences supplied by fossils or by physical features. For example, the *rock salt* deposits of the western counties — and they furnish about one-third of the total salt produced in the entire country — are restricted to a certain position in the Salina shale formation. The geographical limits of this formation have been traced with accuracy so that there is no longer any doubt as to the region that may be profitably explored for that mineral.

In the same way it has been well established that the *gypsum* beds, which have given rise to a very important mining and manufacturing industry, form a special member of the sedimentary sequence having a well-recognized position and a real distribution. With the information at hand the prospector or intending investor may be accurately guided in his search for gypsum properties.

The supplies of *building stones, lime* and *cement* materials, and *clays* for the most part are governed by similar relations of occurrence. The clay deposits have been given thorough investigation from the various standpoints of distribution, chemical and physical characters, and technology of manufacture. Another special report deals with the lime and cement materials, and it is proposed to present the facts regarding our building stone supplies with like detail with a view to assisting their development.

The features surrounding the accumulation of *oil* and *natural gas* are admittedly obscure, though of late years considerable progress has been made toward the establishment of a practical basis for the exploration of these resources. The fact that both oil and gas are more often found in certain kinds of rocks than others is confirmed by experience. It is further recognized that the pools in each field usually occupy a definite position in the stratigraphic column, while their areal distribution may be influenced by the tectonic structures assumed by the strata, by underground water conditions or by other factors that come within the range of geological observation. The studies in the oil and gas territory of New York have been mainly concerned with the determination of the productive horizons for the several districts, in which work some very useful results have been obtained. An inquiry into the specific relations that characterize the

different occurrences, after the plan so successfully followed recently in the larger fields, might yield additional information valuable to these industries.

The *iron ores* of New York constitute one of its large mineral treasures. There are few areas of equal size in which so varied and widely distributed deposits are found. This variety of character is closely related to the geological features that surround their formation, and the interpretation of these features has a more or less direct bearing upon the issue of mining operations. One type of occurrence is represented by the Clinton hematite deposits which occupy a belt stretching across the central and western counties and which are clearly defined as to position by their stratified development. They have recently been explored and mapped. The very important magnetic ores of the Adirondacks, on the other hand, present a wide complexity of form and surroundings, as might be expected from their association with some of the most ancient rocks that are anywhere exposed. Still the study of their features has not been without result, as it has supplied the criteria for arranging them into two or three larger groups, each with a circumscribed geological range.

There remain for future investigation the Highlands magnetite district, the limonites of Columbia and Dutchess counties and the hematite ores of St Lawrence county, all of which have commercial importance.

The minor minerals lend a variety to the productive industry in the State, to which they also contribute very materially in the aggregate. The Adirondack region is the source of most of them. They include *talc, garnet* and *graphite* in extensive deposits that possess peculiar economic value to the trade, as well as *feldspar, quartz, pyrite, lead* and *zinc* which have a more limited representation. The production of zinc ore, it may be noted, has reached commercial proportions only within the last year. The areal mapping now in progress throughout the Adirondacks will help to explain the occurrence of these deposits, but many will repay detailed investigation of their distribution and field of usefulness.

With the gains of knowledge on these subjects has come not only a better appreciation of the positive elements in the State's mineral endowment, but also of the *limitations* that are naturally put upon this wealth and that should be respected by well-intentioned enterprise. The service to be rendered by directing industry into its legitimate channels may be not the least important function of the

geological survey. Time, money and energy have been wasted in pursuit of ventures which by a little inquiry would have been found absolutely futile at the start.

No doubt the fact that the New York series of rock formations does not contain workable coal beds has secured wide currency among the people of the State and its scientific demonstration by the First Survey has been of incalculable benefit in forestalling much fruitless search for coal deposits. There seems, however, to be a need for urging it upon public attention from time to time, as shown by the recent revival of interest in the matter. The regions from which reputed discoveries are most often reported include the Hudson river section, the Catskills and the southern tier of counties along the Pennsylvania border. In none are found rock formations equivalent in age to the proximate coal seams of the Appalachian field, the nearest approach to those being represented by the small areas of carbonic conglomerate in the southwestern corner of the State that are the last outlying remnants of the great conglomerate at the base of the productive measures. There can be no excuse for further waste of effort in mining for coal anywhere within the boundaries of the State.

It is recognized that the limits of the oil and gas fields are not accurately defined as yet, and there are still possibilities for discovering new sources of supply, especially of gas. Exploration may be guided in some measure by the results of geological work, as has been already stated. With the information which is available in regard to the productive formations and their distribution, the more promising territory may be broadly marked out; other considerations, also, show that only a part of the remaining area is at all likely to contain economically valuable pools of either oil or gas. The areas comprised within the Adirondacks and the Highlands are absolutely barren, as they are composed of crystalline rocks. The bordering region of thin or disturbed sediments affords very little chance of productive wells and this is equally true of the great mass of shales and sandstones that constitutes the "Hudson River formation" between the Adirondacks and the Highlands. The territory immediately west of these areas and extending as far as the meridian running through the middle of Oneida lake is of doubtful value, as demonstrated by experience with test wells. The actual productive area is restricted to the central and western parts, including about fifteen counties in all, of which only those near the western border have been found thus far to contain very large pools. In regard to

oil it may be said that the fields are small and it seems improbable that the industry will ever be extended outside of the three counties, Cattaraugus, Allegany and Steuben, where it has hitherto been confined.

Another matter that has been repeatedly discussed in connection with previous geological reports and the need of caution emphasized is the recurrent interest shown in the search for precious metals. The favored ground for prospectors is the Adirondack region where immense accumulations of sand and gravel have resulted from glacial wear upon the local rock formations. The same materials are scattered pretty much over all the section south of that region. There are no mineralized quartz veins to account for the existence of gold in the sands and wherever tested by the usual processes employed by commercial laboratories nothing more than a trace of gold and silver has been discovered. The subject has been treated so often and at such length as to require only passing mention here.

As of basic importance to the mining industry may be mentioned the *geological map,* especially the one now in preparation on the large scale of one mile to the inch. With this base there is attained a degree of refinement in denoting the rock formations and their bounds that should correspond to very general needs. Besides the immediate information it affords in regard to the various classes of quarry materials and stratified deposits available within the region mapped, it serves as a ground plan for directing all kinds of exploration, such as for oil, gas, water and the metallic ores. Its uses extend also to agriculture, engineering, and many everyday occupations.

Engineering. The application of geological methods and facts to various lines of engineering not connected with mining is hardly a new development, though it undoubtedly has assumed a broader aspect in the last few years than before. As an outcome of the public demand for service in the combined fields the profession of geological engineer has now a recognized standing, with a considerable body of practitioners.

In the location and examination of materials used in *engineering construction* the geological survey may render material assistance. This work naturally goes in hand with the field study and investigation of building stones, though requiring somewhat special treatment from the different standpoints with respect to physical quality and availability of the materials. The testing of stone for *road-making* and *concrete* is, of course, a function of engineering laboratories, yet very useful data in the way of preliminary classification may be had from geological methods, specially when aided by a knowledge

of modern petrography. The quality of sands and gravels for general construction purposes may be approximated in a similar manner.

The importance which the present scheme of highway improvement in the State has assumed requires that every possible advantage be taken of the situation with regard to the occurrence and availability of road-making materials. It is not necessary at this time to set forth in detail the geological considerations which enter into the subject. One element among many to be considered is the practical absence of suitable rock materials over the large area occupied by the Devonic shales and thin-bedded sandstones in the southern tier of counties, and the possible application of other local materials for use on the highways of that section. It would appear desirable to have a systematic inventory of the resources that may be drawn upon for road construction.

Another practical side of geological investigation is illustrated in the engineering of large projects which involve unusual care or discrimination in dealing with rock materials. In such cases the correct interpretation of structural features and processes of rock change that are in progress is often of considerable moment, if not on occasion of critical importance. The *foundation work* of large structures like dams and bridges that must be secured against the very slight but cumulative effects of physical agencies, and the excavation of canals and tunnels are examples of this kind.

A notable instance of the varied bearings which geology may have upon engineering is afforded by the construction of the Catskill aqueduct for the supply of water to New York City. The difficulty of the undertaking can scarcely be appreciated without a knowledge of the physical characteristics of the country in which the work had to be accomplished and the complications arising from the magnitude of the project. The engineering plans have been formed only after most extensive exploration of the features related to the surface and rock topography, character of the formations, tectonic structures, underground water circulations, and other matters which from the nature of the problem might influence the course or success of the work. To assemble and interpret the data a staff of geologists was maintained and was in constant touch with the situation. An insight into the manifold character of the scientific investigations and their relation to the conduct of the operations are given in a recent volume [1] prepared by a member of the geological staff. To

[1] Geology of the New York Aqueduct, by Charles P. Berkey. N. Y. State Museum Bulletin 146, 1911.

afford a general outline of the information collected and its bearing upon the work, the following paragraphs are quoted from that volume:

The benefits of the studies have been twofold and reciprocal. On the one side the practical planning of the enterprise has constantly required an interpretation of geologic conditions as a guide to locations and methods and on the other the extensive investigations carried on have given an opportunity for practical application of geologic principles under conditions seldom offered and the data secured in additional explorations serve to make the detail of some of these complex features now among the most fully known of their kind. Examples of such cases are (a) the series of buried preglacial gorges (as in the Esopus, and Rondout and Wallkill and Moodna valleys) and (b) the completed geologic cross sections (such as the Rondout valley, the Peekskill valley, Bryn Mawr, etc.) and (c) the numerous additions to the knowledge of local rock conditions (such as that at Foundry brook, Rondout creek, Coxing kill, Pagenstechers gorge, Sprout brook, and others).

Almost every locality has its own specific problem and its own peculiar differences of treatment and interpretation of features. Nearly all of the studies here presented came to the attention of the writer and others in the form of definite problems or questions involving an interpretation of geologic factors and an application to some engineering requirement. Some of these questions . . . are the location of buried channels beneath the drift, the character and depth of the drift, the kind of bedrock, the condition of bedrock for construction and permanence of tunnel, the underground water circulation, the occurrence of folds and faults, the position of weak zones, the depth required for substantial conditions, and many other similar problems.

The cooperation of the geologist has likewise been sought in solving the difficulties at Panama, though unfortunately it appears this was not secured until the plans were formulated and the work of construction well under way. Many problems encountered in the work were of the kind that required the experience and information of the trained specialist. Some of the more important ones were related to the locations for the locks and dams, for which the element of security was critical, and to the availability of the local resources in building materials. It seems probable that if the results of the survey had been available at the start they would have had even greater value in guiding the course of operations.

In combining the work of the geologist and engineer, Germany seems to be in advance of other countries. Public improvements like canals, railroads, and the regulation of streams are undertaken only after investigations of the geological factors that influence the

plans. In one year alone the geological survey of Prussia was called upon to supply information concerning ten projects relating to canals and streams.

There are few questions more often referred to the geologist than those concerning *water supply from underground sources.* With the crowding of our population many of the streams formerly serving households or communities have been rendered unfit for potable purposes except when subjected to expensive treatment, and consequently deep wells are being put down in numbers. The guidance to be had from detailed maps when these are available, or from records of previous borings into the same formations, should be of very considerable service, specially if supplemented by careful field observations. The general factors governing subterranean water supply, the real relations of the ground waters to the deep waters, and the courses of subterranean drainage, are still little known and here lies a field of much practical importance awaiting future development into accurate knowledge.

A related field of study is afforded by the *mineral springs* which are an important element in the natural wealth of the State. The need for conserving these valuable waters can scarcely be questioned since it is well known that they are liable to deterioration and exhaustion in much the same way as other natural resources; moreover in some places they are the basis of extensive enterprise and lend support to large communities. Governmental ownership or control of mineral springs is a policy that has long been pursued by European states, and recently a step in that direction has been taken with regard to those at Saratoga. The investigation of the waters, in particular the probable conditions of their derivation, storage and areal occurrence, is of pertinent interest to the matter of their conservation. To carry out such investigation is but to follow the precedents established by other countries.

AREAL GEOLOGY

In my last report I gave a list of all quadrangles on the topographic scale of 1 mile to 1 inch which have been issued in the form of detailed and completed geological maps. To this list were added those upon which reports have been rendered, though these are still unpublished, and those on which progress had been made by way of preliminary operations. During the year just closed reports with maps have been issued covering in detail the geology of the Alexandria Bay, Cape Vincent, Clayton and Grindstone quadrangles, all

of these pertaining to the St Lawrence region being brought together into one bulletin and under one title, "Geology of the Thousand Islands Region." The map and report on the Poughkeepsie quadrangle have also been issued. There has also appeared a special report which has proved of much interest to engineers as well as to geologists and the general public, as it deals with the earth structures revealed in the operations of the New York City Board of Water Supply. This report is entitled, "Geologic Features and Problems of the New York City (Catskill) Aqueduct."

In regard to actual work in the field, the progress made may be summarized under these regional headings:

Central and western New York. The areal work in this part of the State has progressed with reasonable celerity. The maps of the following quadrangles have been completed during the year: Dunkirk, Cherry Creek, Eden, Silver Creek, and Westfield, all in the Lake Erie region. Preliminary work has been carried into the Bath quadrangle, and field work has been completed on the Brockport, Hamlin, Albion and Oak Orchard quadrangles.

For this entire western New York region the present condition of the areal survey for the geologic map may be thus summarized.

Quadrangles published:

Auburn	Honeoye	Penn Yan
Buffalo	Naples	Portage
Canandaigua	Nunda	Tully
Elmira	Olean	Watkins
Genoa	Ontario Beach	Wayland
Hammondsport	Ovid	

Quadrangles reported:

Attica	Eden
Batavia	Phelps
Caledonia	Silver Creek
Depew	

Quadrangles mapped:

Albion	Hamlin
Brockport	Oak Orchard
Cherry Creek	Westfield
Dunkirk	

Quadrangles begun:

Bath	Medina

Eastern New York. Last year I recorded the progress made in the study of the region involving the Saratoga and Schuylerville quadrangles. The report on this area is not yet in readiness for issue but so far as present problems go, it is practically completed.

There is an element of special importance given to the study of this region by the presence of the Saratoga springs, the public concern in them since the State has undertaken to acquire and conserve them, and by the long outstanding problem as to the origin or cause of these saline carbonated waters.

Problems of subterranean geology are still obscure and difficult in the present state of the science but in seeking all available light on this, I have asked Prof. James F. Kemp to take over the special investigation of the nature of the Saratoga waters, in the belief that there was much to learn in regard to the origin of the springs which would in some measure serve the public at the present time. This report has been rendered and will presently be published. A summation of its broader results is here communicated.

Saline springs of Saratoga and vicinity. The report discusses the various springs which have been recorded in the region from Albany to Whitehall and is accompanied by a map giving their several locations. It appears that over eighty years ago saline carbonated waters were tapped for a short time by a deep well in Albany. None are known to the north until reaching Round Lake, where nearly as long ago a deep well found a short-lived supply. There is thus an interval of twenty-six miles from Albany to Round Lake in which no mineral waters of this character have been reported. Ballston and Saratoga Springs are next in northerly direction. In these two villages and in the five miles between them the great majority of the springs are situated and here the central area of their activity seems to be placed. The Gurn spring, eight miles north of Saratoga Springs, is the last of the strongly active, carbonated, saline varieties. There are records, however, of feebly active ones at the Quaker springs, eight miles east of Saratoga Springs; of one mildly active seventy or eighty years ago in the valley of the Moses kill, near South Argyle, on the east side of the Hudson river, and of one feebly carbonated, with high calcium content, at Whitehall, thirty-nine miles north of Saratoga Springs. All these remoter springs are weak in both carbonic acid and common salt as compared with those at Saratoga and Ballston. The several springs should be considered in groups along the lines of the great northeast and southwest faults, rather than as forming one belt.

There is next given a statement of the local geology upon the basis of the section established by Cushing and Ruedemann. The fault which traverses the village is discussed in some detail. The

general principles of ground waters follow, in which statement these kinds are established: those from the rainfall, usually described as meteoric; those from cooling and crystallizing bodies of igneous rock, usually called magmatic or juvenile; and those absorbed portions of ancient marine or fresh waters in which sediments are originally deposited and which are carried down with the sediments — connate waters. All three of these waters have been mentioned in the discussions of the springs, although not always under these particular names or in just this definite classification. The general principles which must be fundamental in the study are thus established.

The composition and character of the Saratoga and Ballston waters are next reviewed with care. As a necessary preliminary the methods of recording analyses are summarized and explained. The older ones are generally stated in grains in the U. S. gallon; the later ones in parts per million. The substances reported in the earlier and in many later ones are the estimated salts. The later practice is to use ions, or incompleted molecules, often elements, according to the modern conceptions of solutions. The discussion of the composition is carried out so as to employ all three of these methods of statement and to make the matter clear to any reader having the necessary familiarity with the subject. All the available analyses have been compiled and studied. They easily divide into three main groups in chronological order. One set was made by the early chemists, especially by Dr John H. Steel, and are, except one or two, earlier than 1840. Chemical analysis was then imperfectly developed and fewer ingredients were recorded than in the later ones.

A second set was made by Dr Charles F. Chandler in the 60's and early 70's. This set is quite complete and is of great value. A third set was made in the last ten years, almost all about seven years ago, by the Bureau of Chemistry of the United States Department of Agriculture, acting under the pure food legislation. The most recent set is that made by the State Board of Health for the commission having the springs in charge.

The older sets have been plotted in series of curves, both as salts and as ions, so as to show at a glance the ranges in kind and amount of dissolved substances. In the accompanying discussion the maxima, minima, and ranges are emphasized. Such analyses as are based on artificially strengthened samples are more or less recognizable.

Having reviewed the composition as regards dissolved salts, attention is given to the carbonic acid gas. Its properties of solution in water, especially as affected by pressure and temperature, are stated and its maximum, minimum and general amounts in the spring waters are reviewed. The phenomena of the "water seal" is next explained.

The temperatures of the waters are given, as are also the specific gravities.

The classification of mineral waters in general and of the Saratoga waters in particular receive attention. They all come under the alkaline-saline and saline classes, chiefly the former. All are muriated and sodic. Practically all are carbon-dioxated. Some are lithic, bromic or iodic, one or several.

The variations in the waters from a comparison of the analyses over intervals of time are discussed. In the springs of Saratoga there is an increased strength from the early analyses of 1840 to those of 1870, probably from better casing off of the surface waters. From 1870 to 1903 there is a marked falling off in strength. In Ballston we have not such complete analytical records, but some famous old springs have dropped out of sight and of one deep-drilled well, put down in 1867, we have two good analyses, 1869 and about 1905. There is no appreciable change in composition.

The report concludes with a discussion of the origin or source of the waters, gas and salts. All the views previously expressed are first passed in review. They are practically of two kinds:

First. That the salts are derived from connate sea waters of early Paleozoic age, which were buried with the sediments. The salts are believed to be taken into solution by the meteoric waters derived from the height of land to the west and northwest and then to be brought to the surface by the fault. In stating these views, few have previously given proper attention to the carbonic acid gas, but Dr L. C. Beck, the author of the valuable report on the Mineralogy of New York in 1842, refers it to a source deep within the earth and was correct in his views regarding the solubility and physical behavior of the gas.

Second. That the salts and gas are tapped from some deep-seated source by the fault along which they mingle with the relatively pure surface waters. This view is most definitely stated in a paper by Mr Charles F. Fish which was read before the American Pharmaceutical Association at a meeting in Saratoga Springs in 1880. The volcanic character of salts and gases were mentioned by Mr Fish.

The writer of the report has first sought to compare the dissolved salts with those known to exist in the sea water of today and with the composition usually attributed to the Paleozoic sea. The suggestion is made that the oceanic waters doubtless covered the valley of the Hudson and probably the site of the springs in Post-glacial time.

Judged by their connate representatives elsewhere, the Paleozoic sea is believed by those who have written upon the subject, especially Dr T. Sterry Hunt, to have had more calcium chlorid than sodium chlorid. If so, its connate waters can not account for the Saratoga Springs waters which have vastly preponderating sodium chlorid.

When compared with modern sea water, whether its samples are taken from the most concentrated portions like the Red Sea or the most dilute embayments like the Gulf of Bothnia and the Baltic, or from the open ocean, analogies fail because the dissolved salts of the sea are singularly uniform and all carry in analyses of their evaporated salts 7⅝ per cent SO_4 and from two to five times as much magnesium as calcium; whereas, in the salts from Saratoga waters, when based on analyses believed to be of genuine samples, there is rarely .1 of 1 per cent SO_4 and the calcium exceeds the magnesium. If we recast the Saratoga analyses so as to reduce the calcium to sea water values, on the assumption that it has been dissolved from the limestone, we thereby raise the proportion of sodium from 5–10 per cent above the sea water values. There are other differences believed to be irreconcilable so that it seems impracticable to support the derivation of the salts from sea waters whether connate or Postglacial.

A second and very serious objection lies in the fact that in the Champlain valley there is an indefinite number of faults with greater sections of Paleozoic strata next them and with greater artesian head near them than is the case at Saratoga, but with no development of brine springs.

The carbonic acid gas is next taken up. All its possible sources are passed in review and the conclusion is reached that it is due to igneous forces, of which expiring volcanic action is the usual and most probable one. The existence of the volcanic plug at Northumberland ten or twelve miles east of Saratoga Springs, is cited. That sodium and other chlorids are derived from volcanoes is shown to be a matter of observation.

The conclusion is reached that the source of the salts and the gas, and doubtless of some of the water, is deep seated and while

some may rise directly along the fault, the probable source is beneath the slates to the east of Saratoga. The waters are believed to be impounded beneath the tight slates and following up the dip are tapped off near the fault.

Artesian pressure from the northwest may aid their emergence and probably dilutes their concentration.

The mapping of the *Schuylerville* quadrangle which has been carried forward by Doctor Ruedemann has presented extraordinary difficulties as the region is one where the essentially homogeneous "Hudson river shales" predominate and which the exactitude of stratigraphy requires to be resolved into their essential units. The Canajoharie, Snake Hill and Normanskill formations are all determinable in this mass of shales and sands and have been now delimited on the map. Along the eastern edge of the sheet the Georgian formation, reaching in from the east and occupying the mountainous region, and the belt of supposed Trenton limestone at the foot of the mountains, were mapped. It was found that the Georgian rocks are overthrust on an almost horizontal plane over underlying rocks of later age, the Beekmantown, Trenton, Normanskill and Snake Hill series. This style of mountain making involving such tremendous overthrusting, though recognized in some other mountain regions, has not before been determined as existing in the Appalachian region of New York.

In the "Trenton" limestones of this region a quite impressive fauna has been found which indicates that the limestones are of Fort Cassin age and the fault breccia (the latter both in its pebbles and matrix) carries species of the Rysedorph Hill conglomerate near Albany, and is thus indicative of Atlantic origin in contrast to the Trenton fauna of central New York and the west. The Beekmantown beds are so distinct from those of the Champlain valley that they will be provisionally termed the Bald Mountain limestone.

In the shale region of the *Mohawk valley* work was continued in the resolution of the shale units which have been referred to as the Canajoharie shale, Indian Ladder beds and the Snake Hill beds. The two former terms were mentioned and defined in my report of last year. The Snake Hill beds compose a thick formation of shales, grits and cherts of lower Trenton age typically exposed on Snake hill, Saratoga lake. The fauna and position of these shales indicate that they overlie the Normanskill shales and probably belonged to the eastern or Levis basin. In connection with this work has been

the further exploitation of an eurypterid fauna in the Schenectady shales, the discovery of which was referred to last year.

Field work on the *North Creek* quadrangle which has been in charge of Prof. W. J. Miller was concluded by the survey of the northern portion of the area during the season of 1911. In general the geology is much the same as that of the southern portion of the quadrangle which was referred to in my last annual report, but a few additional features deserve notice.

The greatest single mass of syenite-granite extends from south to north across the quadrangle as a belt from six to ten miles wide, and in it are a few Grenville masses or inclusions of considerable extent. This great igneous rock belt is flanked on either side by large areas of Grenville rocks through which occasional mountains of syenite or granite protrude. The protrusion of these igneous masses to heights of from a few hundred to even two thousand feet above the surface of the Grenville, affords very strong evidence of a decidedly irregular surface of the syenite-granite bathylith just after it was cooled. In some cases faults along one or possibly two sides of the mountain masses have accentuated the height of these igneous rocks, but unless we postulate faults with elliptical or nearly circular strikes, it is evident that much of the present irregularity has been due to the irregularities on the surface of the bathylith at the time of cooling.

Eleven diabase dikes and more than fifty gabbro dikes or bosses have been found within the borders of the quadrangle, and these dikes show a decided tendency to arrangement into groups. The two largest gabbro bosses, each measuring about a mile long and from one-half to three-quarters of a mile wide, have been found in the northern portion of the region. One of these shows interesting effects of contact metamorphism along a wide zone where the gabbro breaks through pink granite. In another case a long narrow diabase dike breaks through a small boss of gabbro and shows excellent contact with chilled diabase margins.

In general the Grenville, being a much weaker formation, occupies the valleys, but in the north there are several well-defined exceptions to this rule and the Grenville extends to the summits of small mountains.

The very interesting occurrence and origin of garnets, in a number of mines in the northern portion of this quadrangle and the one just west, have been carefully studied in the field and laboratory studies are now being made.

A part of the field season was devoted to a detailed survey of the northwestern portion of the *Lake Pleasant* quadrangle. Not enough work has been done to justify any general conclusions for the quadrangle but, in the region so far examined, the Grenville series is only scantily represented, the few small areas noted being not much more than inclusions in the igneous rocks. Only one outcrop of crystalline limestone has been observed.

The great rock masses are syenite (augitic to hornblendic), granitic syenite, granite (pink to gray), and granite porphyry. These rocks all appear to be differentiation products of the same cooling magma. They grade from one type to another so frequently that drawing the boundary lines in such a rough, wooded country is difficult work.

Another rock encountered in fairly large masses is a fine-grained, gray to pinkish gneiss which, at times, shows suggestions of a banded structure. The relation of this rock to the others has not yet been satisfactorily determined.

No gabbro or diabase dikes have been noted, but the occasional gabbro boulders in the vicinity of Lake Pleasant indicate that this rock occurs not far northward.

Valcour Island. The detailed study and survey of this island in Lake Champlain, its rocks and their contents, its origin and bearing on the general history of the lake basin, have been carried forward by Prof. George H. Hudson.

Southeastern New York. During the past year there has been issued Doctor Berkey's important bulletin on the Geology of the New York (Catskill) Aqueduct which has been in large demand from engineers and other students of practical geological problems. The continuation of the aqueduct operations has afforded opportunity to examine the many tunnels and open cuts now nearly at maximum development and to make comparison with the conclusions of earlier explorations. This has been done with considerable care, with particular attention to sections where detail of structure could be worked out. It is only fair to say that there have been no wholly unlooked for conditions yet discovered. The geological formations and structures and conditions already described and based upon preliminary explorations, need little modification from the completed work. It is possible, however, now to class a great many items as facts that have heretofore been given as interpretations, and many details can now be added. The existence of several mud-filled caves in the limestones of the Rondout valley to greater depth than one

hundred feet below sea level has been proven. Faults and minor folds are still more numerous throughout the region than could be seen on the surface. Decayed conditions in crush zones, and in porous layers favorably situated, are known to exist to great depth locally and at depths of less than three hundred feet there are many narrow zones of rock in such condition. Rarely, near the surface, there are extensive occurrences of residuary matters. The tunnel near Garrison in the Highlands passes through over five hundred feet of such rock still preserving the typical formational structure, but so soft that it requires as substantial timbering as would so much glacial drift.

It is the deep explorations, however, that promise the most additional data. The courses of deeper water circulation and its effect on different rock formations are shown at many places. The granites beneath the Hudson river at Storm King mountain show strain to such extent that, in certain zones, slabs crack off from all surfaces as soon as exposed. This rock is penetrated at a depth of one thousand one hundred feet below sea level and all but about five hundred feet of the distance from one side to the other has been exposed. No noteworthy crush zone or fault or other special weakness line has yet been discovered in that section, but jointing is strong and abundant.

The tunnels show more clearly than the surface exposures the intrusive nature of the granites of the Highlands. One new belt of interbedded limestone and associated quartzite schist has been exposed by the aqueduct open cuts. Simple chemical tests on a great many samples of Fordham gneiss from New York City explorations have shown a much wider occurrence of lime carbonate in them than was formerly suspected. Many layers not connected with limestones at all carry a strong lime content.

A hurried reconnaissance and comparison has been made of the granite and limestones of the vicinity of Mounts Adam and Eve in the *Goshen quadrangle* and of the belt toward Franklin Furnace. The granites of that district are strictly of intrusive character. They cut and include older gneisses which themselves contain interbedded limestone layers in every way comparable to those of the region along the Hudson. A short reconnaissance of a small area in the Franklin quadrangle mapped as Pochuck gneiss was made for purposes of comparison with the Hudson river district.

In *Orange county* Dr Henry B. Kümmel has made observations which have an important bearing on the tectonic structure of the

crystalline hills and on the correlation of the Paleozoic stratigraphy with that of New Jersey. This region is one which has been previously studied both in its broader features and in some of its special details but Doctor Kümmel has brought to his examination of it long and exact acquaintance with the geology of New Jersey along the region of the Appalachian uplifts. Incidentally this work has afforded very considerable data for the areal mapping of the region. Doctor Kümmel reports as follows:

Overthrusting of the crystalline rocks. The region south of Greycourt is characterized by a number of isolated masses of gneiss which rise abruptly to notable heights above the surrounding shale country. Northeast of Greycourt is another line of similar hills but less massive and lower than the former. All of these larger gneiss masses have certain topographic features in common which are significant of the structural relations. Both eastward and westward slopes are steep and in places even precipitous. On the west the "Hudson River shale" extends part way up the slope and usually forms a narrow shelf along the mountain face. This shelf commonly attains its greatest elevation along the central portion of the hill and declines gently toward the northern and southern ends. Its inner (eastward) margin is marked by outcrops of gneiss usually rising above the shelf as a low ledge, but sometimes forming cliffs thirty or forty feet in height, above which the slope to the summit is more gradual. Toward the northern and southern ends of the hill the bordering gneiss ledge swings eastward as the shelf of "Hudson River shale" decreases in height. Viewed in profile from the north or south, the contact of the gneiss on the shale and its descent to the east as the end of the hill is approached is clearly shown by the topography.

The "Hudson River beds" within a quarter of a mile of the contact, dip 30° to 50° to the southeast, i. e. toward the gneiss at angles which accord fairly well with the inclination of the thrust plane. Locally the shale beneath the gneiss is minutely crumpled and contorted, even the finest laminae being closely folded as a result of the lateral compression when it was overridden by the crystalline rocks. The gneiss within several feet of the contact is often greatly crushed and traversed by many minor thrust planes which dip southeast at slightly varying angles. Many of these thrust planes are polished and slickensided.

The eastward swing of the contact between shale and gneiss with decrease in elevation, the crushed and slickensided condition of the

gneiss along the contact, and locally the crumpled state of the shale would be sufficient evidence to demonstrate that the gneiss had been overthrust upon the shale, even if the actual contact were not visible at a number of places.

The general trend of both the thrust plane and of the normal fault or faults which limit the gneiss on the east is east of north. At intervals another series of faults, trending northwesterly, intersect and dislocate the former. These are probably also normal faults along which the offset has usually been to the right as one faces the fault plane. In this they correspond to the great majority of the faults which intersect the magnetic iron ore bodies of northern New Jersey.

The relative age of the faults is plainly indicated. The thrust faults are the oldest, and the cross faults, i. e. northwest-southeast trend, are the youngest. The northeasterly trending normal faults are intermediate in age, although not necessarily much older than the northwest faults. Their absolute age is not so readily determined. In northern New Jersey there is evidence that the early movements in the Appalachian revolution which marked the close of the Paleozoic era were in the form of thrusts and that later the beds were folded, the thrust planes themselves being involved in the folding. By analogy it is assumed that the thrust planes in Orange county were formed at the same time as those farther south, particularly since Siluric and Devonic strata are involved in the movements. The normal faults are correlated with the movements, which raised, tilted and faulted the Triassic beds in the region only a few miles to the east and brought about the close of that period of sedimentation.

Correlation of Devonic strata in the New York and New Jersey areas. In 1901, Kümmel and Weller[1] described, under the term "Newfoundland grit" a thick-bedded, fine-grained conglomerate below and a white to greenish sandstone above, having an estimated thickness of about two hundred fifteen feet. The basal portion, so far as exposed, is composed of white quartz pebbles from one-fourth to one-half an inch in diameter, usually set somewhat loosely in a silicious matrix, so that the rock is of open texture and friable. Locally, however, the interstices are filled with a silicious cement and the rock is decidedly quartzitic. These coarser beds grade upward into a hard, greenish, thin-bedded sandstone, above which are

[1] Kümmel and Weller, Annual Report of the State Geologist of New Jersey, 1901.

outcrops of a black argillaceous shale, the Cornwall shale, carrying a Hamilton fauna. In New Jersey this grit forms a narrow belt parallel to the outcrops of the Longwood shale (Siluric), but separated from it by the Decker Ferry limestone which has been correlated by Hartnagel and others with the Wilbur limestone and the Rosendale cement beds of the upper part of the Salina of New York. The base of the grit has not been observed in New Jersey, and although its outcrops are nowhere far removed from the probable occurrence of the Decker Ferry limestone, there is always a concealed interval between them, so that the beds immediately subjacent are unknown.

On the basis of a small fauna found by Weller at two localities, one in the coarser beds and the other in the finer and upper layers, the formation was referred by the authors cited to the Onondaga, although some previous workers (Merrill, Darton and others) had regarded it as Oriskany. It is the lowest Devonic formation recognized in the New Jersey portion of the Green Pond area. Owing to a ruling by the board of geologic names of the United States Geological Survey, this formation has been called the Kanouse sandstone in several of the recent geologic folios.

The formations which immediately underlie the Kanouse (Newfoundland) sandstone of the New Jersey area are well exposed in a relatively new section at Highland Mills, New York. This section described by Clarke[1] is from the base upward as follows: (1) thin-bedded sandstones (Port Ewen beds?) 55 feet; (2) heavy-bedded sandstone (Oriskany) 13 feet; (3) thin-bedded blue sandstone, 14 feet; (4) heavy-bedded sandstone lighter in color and becoming coarser upward, 230 feet (these beds represent the Esopus and Schoharie grits). The highest beds exposed at Highland Mills are a few feet of thick-bedded white quartzite and conglomerate exactly like the basal beds of the Kanouse sandstone as exposed at Newfoundland, New Jersey and west of the southern end of Greenwood lake, and as the latter have been referred to the Onondaga as determined by Weller, the uppermost beds of the Highland Mills section may be so regarded.[2]

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[1] Clarke, J. M., N. Y. State Museum Memoir 9, pt. 2, p. 137.

[2] While the Onondaga limestone stage may be represented in the Kanouse sandstone, it seems a nearer expression of the exact relations that the Kanouse sandstone be regarded as the expression of the coarsely clastic earlier deposits of the Onondagan division, that is, a near equivalent to the Schoharie grits. J. M. C.

Darton, Ries, Hartnagel and others have described a fine-grained conglomerate at the north end of Pea Hill, near Cornwall, and six miles north by east of Highland Mills. Lithologically it is identical with the conglomeratic beds at the extreme top of the section at Highland Mills and with the conglomeratic portion of the Kanouse (Newfoundland) formation of New Jersey. It has the same stratigraphic position as those beds and underlies the Cornwall shale of Pea Hill, although not in actual contact with it. No doubt is entertained as to its being the same formation, in spite of the fact that certain characteristic Oriskany fossils have been reported from it. The rock is very hard and fossils are few and not readily obtained. It is not at all impossible that they have been wrongly identified as was the case with the earlier finds in the similar beds near Newfoundland which were regarded as Oriskany.

In this connection it should be noted that the Oriskany strata identified by Clarke in the Highland Mills section carry many fossils in large masses and are heavy-bedded, fine-grained sandstones with no trace whatever of pebble-bearing layers or conglomerates, and that they lie 244 feet below the layers of grit and conglomerate at the top of the section.

At Pea Hill there is a covered interval of considerable width between the New Scotland limestone and the conglomerate heretofore regarded as Oriskany, so that there is room for at least a portion, if not for all the beds of the Highland Mills section, even if we do not consider the possibility of the loss of a part of the section by faulting.

In view of all these facts there can be no question that the conglomerate at Pea Hill should not be referred to the Oriskany, but to the Onondagan, including perhaps the top of the Schoharie. If it contains Oriskany fossils as previously reported (which perhaps may be doubted in view of the fragmentary and poorly preserved nature of the material) their presence may indicate a return of the Oriskany fauna at a later period, as suggested by Hartnagel.[1]

Along the western margin of the Green Pond-Skunnemunk mountain syncline there is a series of disconnected outcrops of a coarse white quartz conglomerate. They vary in size from small exposures of a few square yards to ledges a mile in length and a hundred feet or more in height. The most conspicuous of these are (1) north of Bull Pond, (2) south of Oxford Depot, (3) several small areas a mile east of Oxford Depot, and (4) south and (5) southwest

[1] Hartnagel, C. A., N. Y. State Museum Bulletin 107, 1907, p. 43.

of Woodcock Hill. With perhaps the exception of several small areas east of Oxford Depot these conglomerates are without question parts of one formation, their separation being due to the numerous faults which have affected this portion of the area. Although no fossils have been found in them they have been correlated by several writers with the conglomerate at the north end of Pea Hill near Cornwall and assigned to the Oriskany. Lithologically they resemble the lighter colored phases of the Shawangunk (Green Pond) conglomerate much more than they do the conglomerate at Pea Hill, in that they are coarser, denser and less frequently present the open texture which often characterizes the latter. Where best developed they greatly exceed it in thickness. Moreover recent road excavations have at several points revealed the presence of the Longwood shales which normally overlie the Shawangunk (Green Pond) conglomerate, in close proximity to and above these conglomerates. It seems therefore, necessary to correlate them with the Shawangunk (Green Pond) conglomerate, and not with the conglomerate at Pea Hill. As already pointed out, the latter is to be correlated with the Kanouse (Newfoundland) grit of the New Jersey area and is Onondagan and not Oriskany in age.

Manhattan and Staten Island. Pursuing a definite plan for the acquisition of all new data relating to the geology of New York City, Doctors Kemp and Berkey have brought together details exposed in the course of municipal and private construction undertakings, and Doctor Hollick has continued his records relating to the special geologic features of Staten Island.

Long Island. Professor W. O. Crosby's report on the general geology of Long Island, will, it is believed, be soon in readiness for publication.

SURFICIAL GEOLOGY

The study of the origin and history of the surface deposits in the Schenectady region has been carried forward to completion by Dr J. H. Stoller and his report is now in press. Over about one-half of the area of the *Schenectady quadrangle* the deposits were made in the glacial lake known as Lake Albany. These deposits consist in general of an underlying bed of evenly stratified dark clays grading into overlying sands. They are well exhibited in the vicinity of Schenectady where the Mohawk river has cut into the mass, forming a crescentic bluff in which a thickness of about one hundred feet of clay covered by some fifty feet of sand is exposed. This mass is a portion of the extensive delta deposit which stretches southeast-

ward from Schenectady to the Hudson valley, the surface of which forms the sand plain crossed by the New York Central railway between Schenectady and Albany.

The Lake Albany deposits cover the greater part of the eastern and northeastern portions of the sheet, the materials here representing sediments laid by waters moving in the general valley of the Hudson. An interesting locality is that of the region of Round lake. This lake lies in the middle of a depression, some four square miles in areal extent, the bottom of which is largely strewn with boulders while the slopes consist of the clays and sands of the Lake Albany deposits. The depression is probably a portion of an old rock valley, as interpreted by Woodworth, but its present topographic features are due chiefly to the erosive action of powerful currents of water which, soon after Lake Albany began to subside, swept across this region. These currents were a portion of the Mohawk flood of the Lake Iroquois stage of that river, diverted northward through Ballston channel and thence easterly across the Round lake region.

The elevation of the undisturbed Lake Albany deposits is about three hundred fifty feet in the locality of Schenectady. In the southeastern portion of the quadrangle the elevation is less but along the eastern border of the sheet, north of the Mohawk river, the deposits rise to a gradually higher level and in the plain east of Malta show an elevation of three hundred eighty feet.

A glacial lake not hitherto reported is that named Lake Alplaus which occupied the lowest portion of the extensive basin lying between the slope of the Glenville hills on the west and the Charlton hills on the north. The deposits made in this lake have an elevation of four hundred twenty feet. Lake Alplaus resulted from the accumulation of morainic materials at the time of the recession of the ice sheet, forming a barrier behind which glacial waters became ponded. The greater portion of this moraine, especially in the locality southeast of the village of Burnt Hills, exhibits the characteristic features of morainic topography.

In general the uplands portions of the quadrangle above the levels of the lacustrine deposits are covered with unmodified till. Some interesting evidences of extensive ice erosion were observed. Most notable is that of the broadening and deepening of the Ballston channel, a great troughlike depression which extends from near East Line southeasterly to the present Mohawk valley near Aqueduct. This channel is preglacial in origin, following a line of

highly tilted rock-strata, but there are convincing evidences that it was greatly modified by ice erosion. It was through the gouging action of moving ice with inclosed fragments of rock that the bed of Ballston lake, a long narrow body of water which occupies the lowest portion of the channel, was formed.

On account of the weathered condition of the underlying shales, where exposed, glacial scratches are infrequent but they were observed in five localities. The directions of the scratches ranged from 22° west of south, about one mile northeast of the city of Schenectady, to 57° west of south at a locality near the western boundary of the sheet.

It has long been known to geologists that the gorge of the Mohawk beginning at Aqueduct is postglacial in origin. An interesting part of the present work was the determination of the conditions under which the gorge was formed. When Lake Albany was at its greatest development the Mohawk river discharged into that body of water at about four miles northwest of Schenectady and built a delta out into the lake as referred to above. It was probably at this time that the preglacial channel of the Mohawk was filled up with deposits. When Lake Albany began to subside the delta emerged as land surface and the Mohawk currents became confined within a channel conforming with the present basin near Schenectady. A spillway became established across the rocks below Aqueduct. At the same time the impeded waters, everywhere pressing against the slopes of the basin, gradually forced a passage into the southern end of Ballston channel. These northward moving currents emerged from the channel near East Line, there discharging into Lake Albany. The two outlet streams from the Mohawk basin to Lake Albany were maintained as long as, through erosion, their beds were kept at the same level. This equality of erosive effects was probably determined by the circumstances that the rate of subsidence of Lake Albany was no greater than the rate of lowering of the beds of the two streams by erosion. At length, however, owing to the greater extent of bed of the Ballston stream, it failed to deepen its channel as rapidly as its rival and its waters were drawn off in favor of the Aqueduct course of the Mohawk.

A beginning was made by Doctor Stoller in mapping the surface deposits of the Saratoga quadrangle. A considerable portion of this area appears to be covered by materials laid down by Lake Albany waters at different stages of their existence. The work will be continued into the following season.

The closing phase of glaciation in New York has been particularly studied by Professor Fairchild somewhat in conclusion of his many years of work on the postglacial waters and deposits of this State. Professor Fairchild has submitted a summary of his observations on this subject which is incorporated herewith:

Recent surveys by the Canadian government have given us reliable altitudes along the international boundary in the towns of Havelock and Franklin including the Covey hill district of northern New York. This locality is critical for the study of the Pleistocene phenomena associated with the close of glaciation in New York, and for determination of the ancient water planes and their deformation in the St Lawrence and Champlain valleys.

The summit of Covey hill is 1120 feet above ocean, which is 90 feet higher than the figure used by Doctor Gilbert and by Professor Woodworth in his description of the Mooers quadrangle (N. Y. State Museum Bulletins 83, 84). Taking advantage of the precise altitudes now available on the Canadian side of the boundary the glacial drainage features and the marine shore line have been mapped in the area connecting the Champlain and St Lawrence valleys, revealing an interesting history that is given here in brief outline.

The glacial Lake Iroquois found its second outlet at the Covey gulf, the channel being at somewhat over 1000 feet altitude. The level of the lake and river is estimated at 1025 feet altitude, which is 565 feet higher than the lake level of the previous outlet at Rome.

The highest bars of the marine beach are at least 525 feet above sea, and they retain this height around the north slope of Covey hill and westward until they reenter New York, at Boyd's lines, five miles north of Chateaugay village. This shore has been traced in practical continuity as far as Potsdam, where its altitude has fallen to 480 feet. The correlation of this shore line with the beaches in Jefferson county is now positive.

The deformation of the Iroquois plane furnishes evidence of the marine origin of the Covey hill beaches. The Covey gulf channel at the time it carried Iroquois outflow must have been as low at least as the Rome outlet, or 565 feet lower than it is now (1025–460). The depression of Covey hill by 565 feet would carry the top of the Covey beaches (now 525 feet altitude) 40 feet below sea level. This excess of submergence will be explained later.

The slow lifting of the land out of the sea produced a remarkable series of close-set bars. On the east and west road near the north edge of the Mooers quadrangle forty-two bars are counted in a distance of one and one-fourth miles and through a vertical fall of only 165 feet, or from 525–530 down to 365 feet. Similar series of crowded cobble bars are noted on all the roads in Canada which traverse the beach; at Covey Hill P. O., Stockwell, Maritana, Franklin Center, Rockburn and Brooklet. Some stretches of the marine shore in New York are as heavy and impressive as the

Cobble bars on marine shore

Upper figure. Northwest of Franklin, Quebec. Looking west along the seventh bar from the summit.

Lower figure. Northwest of Franklin, Quebec. Looking east along the eighteenth bar from the summit.

Boulder moraines

Upper figure. One-fourth mile south of Shea's lines, and one and one-half miles south of Covey Hill post office.

Lower figure. Excavation in summit of Cobblestone hill, three miles northwest of West Chazy.

stronger portions of the Iroquois beach, notably a stretch of about ten miles in the town of Lawrence, St Lawrence county. In contrast some sections require close examination to determine the upper limit of wavework.

The declination of the shore line from Franklin, Quebec, to Potsdam, N. Y., and on to near Watertown, is slightly less than one foot a mile. On the east side of the Covey hill salient, in the Champlain valley, the beach declines at the rate of about three feet a mile in direction some 20 degrees east of south. The isobars seem to lie about 10 degrees south of west, which makes the direction of steepest uplift about 10 degrees west of north. This explains the nearly level attitude of the beach in Canada.

The Iroquois shore is now approximately known throughout its reach from Covey gulf to Watertown, being located chiefly by the heavy deltas on the principal streams, but with good bars or shore line features at several localities. The deformation of the Iroquois plane in northern New York is 2.4 feet a mile in the southwest direction, using the highest bar at Watertown (733 feet). Using the lower series of bars (671 feet), which probably represents the later or Covey gulf plane, the deformation is 2.9 feet a mile. The beach is nearly parallel to the marine shore, the intervening distance being five to seven miles.

Between the Iroquois and the marine planes are two other water-levels. The continuity and importance of these intermediate planes was first recognized by Professor Chadwick, who has specially studied them on the Potsdam and Canton quadrangles. The explanation of these lakes necessitated reexamination of the slopes of Covey hill and study of the Pleistocene features in the Champlain valley.

It appears that the waning Labradorian ice sheet lay close about the Covey hill promontory, as if reluctant to yield its hold on New York. Because the flow movement was from the northeast the ice body pressed with more force on the east side of the salient, so that when the Iroquois waters, creeping northward in the St Lawrence valley between the ice border and the Adirondack highland, finally reached the low pass across Covey hill, they found the ice still closely investing the Champlain side of the highland. The outflow at Covey gulf, successor to or contemporaneous with the Rome outlet, was held up at high levels and produced heavy and characteristic iceborder drainage phenomena. A river as large as the St Lawrence, with ice for its eastern channel wall, flowed southeast across the towns of Mooers, Altona and Beekmantown and stripped large areas of Potsdam sandstone bare of drift, as described by Woodworth in his papers on the Mooers quadrangle. In its earliest flow the Altona river (as we propose to call the flood) had very little fall at Covey hill, but curved southeast and then south some eight miles to the valley of the north branch of the Big Chazy river, then southeast and south some fifteen miles until it poured its flood into the glacial Lake Vermont (named by Woodworth) at

an elevation of about 800 feet. The enormous volumes of coarse detritus carried by the Altona river was first thrown into Lake Vermont southeast of West Beekmantown, at and south of the hamlet known as Beartown, where an area of several square miles is buried under coarse delta stuff which might be mistaken for moraine. The courageous farmers have tried to clear the land by building huge cobblestone fences around small fields, which fields are yet masses of cobble.

As the ice sheet weakened and the Altona river was lowered on the land slope Lake Vermont was also falling and the stream detritus was dropped at about 700 feet altitude two miles north of West Beekmantown and three miles southwest of West Chazy. The closing phase of the drainage was into Lake Vermont at about 600 feet, producing heavy deposits at Cobblestone hill, northwest of West Chazy.

The areas of stripped and eroded rock are the most striking and peculiar features of the region. These are the Stafford's rocks between Covey gulf and Cannon Corners, with altitude 900–765 feet; Blackman's rocks, southeast of Cannon Corners, about 800–700 feet; and the Altona bare rocks, 900–620 feet. The channeling erosion by the Altona river has produced a striking series of north and south valleys south of the bare rocks. The correlation of the bare rock areas with the Covey gulf was correctly predicated by Woodworth.

While the ice front was holding the river flow along the lower edge of the Altona rocks the ice weakened on the north slope of Covey hill so that Lake Iroquois found escape around the promontory and was lowered to the level of the Altona river, toward 700 feet. This stream control, along the east side of Pine ridge, established for a time a lake in succession to Iroquois, which we propose to call *Lake Emmons* (after Ebenezer Emmons whose district in the first geologic survey of the State covered this territory, and who first drew attention to Covey gulf). For a relatively brief period Lake Emmons occupied the Ontario basin, producing some conspicuous delta sand plains. It left a few strong beaches, near Altona, at Cannon Corners and at the extreme northwest corner of the Mooers quadrangle, the altitudes ranging from 740 down to 680 feet. The strength of these bars, formed in a narrow lake, is surprising and is not satisfactorily explained, unless we can attribute the effective wave action to the calving of small icebergs or the dumping of the ice front in shallow water.

This sequence of events connected with the Covey gulf river explains why no high cataract cliff was formed at the east end of the gulf. All the flow except possibly the very latest was held up to high level and forced south by the obstructing ice front. Even the greatest drop could be only 250 feet, or to the level of Lake Emmons. A swamp filling at the Emmons level occupies the old valley below the gulf. Probably the outflow of Iroquois was diverted from the gulf to the north side of the hill while the ice front was holding the

Altona stream flow at high levels, so that no great volume of water ever fell through the vertical interval from Iroquois (1000) to Emmons (750).

When the ice barrier was removed in the Altona district Lake Emmons was lowered into Lake Vermont, and the latter lake in its turn occupied the St Lawrence and Ontario valleys. This expanded lake will be called *Vermont-New York*. Its deltas are broad on the Grass, Raquette, St Regis, Salmon and Chateaugay rivers, and Chadwick has found some good shore line features.

Eventually the ice sheet weakened on the Vermont side of the Champlain embayment and Lake Vermont-New York was drained down to sea level and oceanic waters took possession of the Champlain, St Lawrence and Ontario valleys at the same time.

The Covey gulf outlet of Iroquois to have been effective must have been at least as low as the Rome outlet, but now it is 565 feet higher. The postmarine uplift at Covey hill, that is since the ocean was admitted there, is definitely 525 feet according to the figures of the Canadian topographic map. This excess of at least 40 feet submergence represents the amount of uplifting of the district during the interval of time between the extinction of the Covey gulf river and the construction of the earliest marine beaches. This interval covers the duration of the downdraining of Iroquois to Emmons and the periods of life and downdraining of Emmons and Vermont-New York. It would appear that this interval was only a small fraction of post-Iroquois time.

The vertical interval between the shore lines diminishes southward along with the altitudes. For the St Lawrence valley the altitudes and intervals are given approximately, in the following table, subject to future correction.

Comparison of shore lines in the St Lawrence valley

LAKE	COVEY HILL		PARISHVILLE–POTSDAM		FULLERVILLE–GOUVERNEUR [1]		WATERTOWN	
	Altitude	Interval	Altitude	Interval	Altitude	Interval	Altitude	Interval
Iroquois	1 025	275	920	225	815	183	733	(153)
Emmons	750	100	695	95	632	87	(580)	(80)
Vermont-New York	650	125	600	120	545	110	(500)	(100)
Oceanic	525	.....	480	.....	435	.....	400	.....
Total interval..		500		440		380		333

[1] The figures for the Fullerville-Gouverneur section and those in parentheses are calculated and theoretical.

INDUSTRIAL GEOLOGY

Building stone. During the past field season an inspection of the quarry localities was undertaken by the assistant state geologist with the aid of Mr R. W. Jones of the staff. It was found

impracticable to extend the operations in the few months available beyond the crystalline rocks of the Adirondacks and southeastern New York, but it is aimed eventually to cover the quarries of the whole State. Sufficient observations and materials are in hand for a detailed description of the granites and other silicate rocks, which is now being prepared. According to the plan to be followed the information will include results of physical tests, chemical analyses and microscopic examination of representative specimens, so far as they can be secured or made for the special purpose of the report.

The last complete work on the building stones of the State is that by Smock which was published over twenty years ago.

The great expanse of crystalline rocks included in the Adirondacks and the outlying region affords a variety of quarry materials, some of which are suitable for building and ornamental uses and are classed by the trade under the general term of granite. The most widespread types comprise granites proper, syenites and anorthosites. Gabbros, dike rocks and gneisses have more limited applications but are serviceable for local purposes of road improvement, engineering construction, or rough work in which durability rather than an attractive appearance is the essential requirement. The development of the quarry industry in the Adirondack region has been retarded by lack of proper transportation facilities. Though these are much improved, compared with the conditions twenty years ago, there is less security for new enterprises by reason of competition from the established industries of other states. Only for materials of exceptional beauty or quality can any extensive sale be anticipated under present conditions.

One of the better known granites of this region is found in the outlying area of crystalline rocks exposed along the St Lawrence river from Clayton to Alexandria Bay. The rock is called Picton granite in Cushing's recent report on the St Lawrence region but the general trade term is Thousand Islands granite. It outcrops over parts of Wellesley and Grindstone islands, as well as many of the smaller islands in the river, and has a characteristic bright red color and a texture varying from coarse to fine. It has been quarried quite extensively for building, monumental and paving stone. It ranks with the best of American red granites. Picton island is the main source of present supply; a fine grained variety found there is distinguished by its beautiful pink color.

An area of red granite which hitherto has not been mapped or

described is found in the towns of Fine and Pitcairn, St Lawrence county, probably extending also into the adjacent part of Lewis county. It is traversed for several miles by the Carthage and Adirondack Railroad, in the stretch from Harrisville to Benson Mines. It is undoubtedly one of the largest bodies of massive granite in the Adirondacks. Compared with the Thousand Islands granite it has a lighter color and more acidic composition. The color and texture vary from place to place, but there is an abundance of sound and uniform material in the exposures which occur on the slopes and summits of ridges that have been denuded of soil by forest fires. Both in its situation and general character the granite seems to offer opportunity for exploitation, at least to supply some of the nearer markets.

Another characteristic stone of the Adirondacks that has possibilities for quarry operations is the green syenite which recent field work has proved to be of very general occurrence. In most outcrops it shows laminated textures, but residual cores with the original massive arrangement of the minerals are found in places. One of these, noted in the report on Adirondack magnetites, outcrops at Ausable Forks where quarry work has been recently undertaken on several properties. The syenite is too somber in color for most building purposes and its sale is practically restricted to the monument trade. Its unusual color, a dark lustrous green when polished, and its capacity for taking the most delicate designs, which it shows in strong relief, have attracted very favorable notice.

Some varieties of the Adirondack anorthosite, particularly of the granulated lighter-colored phases, are adapted to architectural work, though never used very extensively for such purposes. The vicinity of Keeseville affords many exposures from which most of this material has been taken. An area just south of Ausable Forks, now under development, yields a medium-gray uniform stone resembling granite in its general appearance. The results of experimental tests indicate that the anorthosite of this region is one of the best fire-resisting stones anywhere found.

In the southeastern crystalline area of the Hudson Highlands there is a considerable range of quarry materials, including granites, diorites, diabase and gneisses, but the better grades suitable for building and ornamental purposes are rather restricted in variety and occurrence. These are found in the local granitic intrusions which have broken through the country gneisses, or else in the

residual more massive portions of the gneisses themselves which are derived from earlier plutonic eruptives. Some of the granite intrusions belonging to the former class are those near Lake Mohegan, Garrison, New Rochelle and Pine Island. The Yonkers gneiss, a slightly laminated pink granite, and the Storm King gray gneissoid granite have been quarried quite extensively. In commercial importance the Palisades trap or diabase outranks all the other quarry materials from this section, though it is used solely as crushed stone.

Feldspar and quartz. In connection with the inspection of the granite quarries opportunity has been given to visit many of the pegmatite occurrences which accompany the crystalline rocks in the Adirondacks and southeastern New York. As sources of quartz and feldspar the pegmatites have considerable economic interest, particularly with reference to the local pottery industry which would derive some advantage from having supplies close at hand. At present practically all of the pottery spar and quartz is brought in from other states, the local production being limited mostly to the commoner grades. The inquiry is still in progress but will be completed as soon as practicable and the results prepared for publication.

Mineral statistics. The annual review of the mines and quarries for the year 1910 showed a total production by these industries valued at $35,400,257 or a little more than the aggregate reported for the preceding year. Activity was most noticeable in the early months and was followed by a period of dulness and depression, so that as a whole the year was not specially prosperous. In some departments, however, notable gains were made. The amount of iron ore hoisted from the mines reached the highest total on record, slightly exceeding one and a half million gross tons. The outputs of portland cement, gypsum, natural gas and salt also made new records. The effect of these increases on the total was partly counterbalanced by a falling off in clay manufactures and quarry materials, which constitute very important items of local production. In consideration of the general industrial situation during the year, the record may be regarded as very satisfactory.

Miscellaneous. Brief field trips were made during the year to various localities where new or interesting developments have been in progress.

The opening of new talc mines in the Gouverneur district and at Natural Bridge afforded opportunity to secure additional data on

the occurrence of that mineral and to increase the collections with some handsome specimens. The geological features of the deposits have already been described by C. H. Smyth, jr.

The occurrence of zinc in commercial quantity in the State seems to be fairly well established by recent exploration which has been under way near Edwards, St Lawrence county. At the time the deposits were inspected in the early summer, explorations had reached a depth of one hundred feet on one of the ore bodies, showing a continuous vein or band of zinc blende all the way. It is reported that active mining work will be started early next season. Besides the group of ore bodies near Edwards, which thus far have alone been developed to any extent, zinc blende has been discovered at several places in the stretch of country between Edwards and Sylvia Lake, where most of the fibrous talc is mined. The occurrence of the two series of deposits in close proximity, as well as in the same geological formations, may have some underlying principle and invites investigation.

Interest in the so-called gold sands of the Adirondacks has continued; many inquiries in regard to the matter, also samples of the sands from different localities, have been submitted during the year. It does not appear from any information obtainable that substantial progress has been made toward a commercial solution of the question and until this is reached there can be no basis for soliciting public support in the ventures. The recording of claims, meanwhile, is the most active manifestation of enterprise.

Office work. In addition to the research work the office duties have involved considerable correspondence on matters relating to the mineral resources of the State. So far as may be consistent it is aimed to make the information and facilities at hand available to the public. Samples of ores and minerals may be submitted for identification or an opinion as to their commercial value when it can be given without quantitative assay or chemical analysis. Investigations of the latter kind for private purposes are rather the function of commercial laboratories than of a geological survey.

SEISMOLOGIC STATION

In March 1911 the seismographic station completed the fifth year of service. From the start it has shown a degree of efficiency creditable to the mechanical equipment and has fully demonstrated the practicability of conducting observations of this kind under the somewhat peculiar natural conditions that obtain in its vicinity. The

instruments have been kept in continuous operation, except for brief stoppages necessary for cleaning the working parts and their readjustment. The list of records includes tracings of nearly all the important earthquakes that have occurred during the period, even covering such remote areas of disturbance as India and Central Asia. In general, therefore, the results secured at the station have been quite satisfactory.

With the approaching removal of the Museum offices and collections to the Education Building, the future maintenance of the seismographical work presents some questions for consideration and decision. If the station be continued in its present quarters a good deal of inconvenience and extra labor must be assumed by those in charge. Furthermore, the inability to exercise immediate supervision of the instrument may entail a marked loss of efficiency, compared with the previous service. The seismographs are still in good state of repair. At the time they were purchased they represented one of the most approved types, but since then larger and more sensitive instruments have been developed so that they are now somewhat inferior to those placed in the more recently established stations. Their future service, therefore, will probably be of less value comparatively than it has been in the past. On the whole it seems of doubtful expediency to undertake the expense of providing piers and other necessary adjuncts for their remounting in another place. The alternative that is practically presented in the circumstances is either to continue the existing station with the additional outlay of time and labor required for its future supervision and with correspondingly less returns in the way of results, or else to erect a new station at a convenient place, preferably in the Education Building, and equip it for the most efficient service.

The number of earthquakes recorded for the year ending September 30, 1911, was nine, as compared with nineteen in the preceding period, making a total of eighty-six separate disturbances since the station was established. The frequency, therefore, has shown a marked falling off during the year and as might be expected there have been relatively few microseisms. The small number of distinctive shocks reported throughout the world indicates at least a temporary halt in the succession of violent disturbances that extended altogether over several years and entailed such disastrous consequences in San Francisco, Valparaiso, Kingston, Northern India, Messina and Costa Rica. Most of the tracings have been of very small amplitude and from uncertain sources.

RECORD OF EARTHQUAKES AT ALBANY STATION, OCTOBER 1, 1910 TO SEPTEMBER 30, 1911

Standard time

DATE	Beginning preliminaries			Beginning principal part			Maximum			End			Maximum amplitude
1910	H	M		H	M		H	M		H	M		mm
November 6	3	43	P. M.	3	51	P. M.	3	52	P. M.	4	50	P. M.	12
November 26	12	01	A. M.	12	41	A. M.	12	47	A. M.	2	58	A. M.	10
December 10	4	52	A. M.	5	24	A. M.	5	35	A. M.	7	30	A. M.	5
December 13	7	05	A. M.	7	33	A. M.	7	40	A. M.	9	15	A. M.	10
December 16	9	47	A. M.	10	22	A. M.	11	00	A. M.	12	20	P. M.	5
1911													
January 3	6	43	P. M.	7	03	P. M.	7	18	P. M.	9	15	P. M.	120
May 4	6	48	P. M.	6	57	P. M.	.....			7	39	P. M.	½
September 16	10	40	P. M.	11	04	P. M.	11	07	P. M.	12	08	A. M.	5
September 22	12	06	A. M.	12	25	A. M.	12	26	A. M.	1	†	A. M.	3

November 6th. Apparently from a source within 3000 miles of Albany. North-south component most distinct.

November 26th. A microseismic tracing, very prolonged in its preliminary phase. May be a compound record, without definite relation between the phases.

December 10th. The record of a long-distance quake, probably 7000 or 8000 miles away. North-south component very weak.

December 13th. The beginning was probably earlier than the time given; no definite break existed between the first discernible tremors and the usual line.

December 16th. Only the east-west component represented. The record gives uncertain readings, perhaps from conflicting disturbances.

January 3d. The heaviest quake of the year, and comparable in its tracing to any of the shocks hitherto recorded. The east-west component was alone received, owing to a temporary stoppage of the second pendulum for repair. The center of the disturbance was in Russian Turkestan where it inflicted considerable damage and loss of life.

May 4th. Faint tremors showing no division between the preliminaries and principal part.

September 16th. A characteristic tracing of a small and distant shock.

September 22d. Appears to have originated in vicinity of Prince William sound, Alaska.

MINERALOGY

In pursuance of the investigation of the recent mineral occurrences of New York City, specimens from four localities have been studied in some detail, furnishing material for several short papers appearing

in this report. The material on which these notes are based has been kindly loaned for study by the New York Mineralogical Club and an individual New York collector. One new form for pyrite, two new forms for chrysoberyl and two new forms for pyroxene are recorded in these notes. In addition the minerals from Newcomb, Essex county, have been made the subject of a crystallographic study of some detail involving the species tourmalin, arsenopyrite and zircon. This study has added two new forms for tourmalin and two for arsenopyrite. Some preliminary work has been done on the occurrences of quartz in the Little Falls dolomite of the Mohawk valley as well as a large number of unpublished crystallographic determinations on New York City minerals and extralimital species.

The preliminary work connected with the installation of the collections in the hall of mineralogy involving the details and arrangement of cases has been completed. This work has been supplemented by the preparation of plans and schedules of types of cases involving the entire case installation for the Museum exhibits for the Education Building.

Several notable additions to the mineral collections have been made; barite from Frizington, England, a series of quartz specimens in groups and loose crystals from Amsterdam, Montgomery county, and others. The quartzes are remarkable in their sharpness and transparency and compare very favorably with the famous crystals from Herkimer county. These crystals occur in every instance implanted on a thin layer of chalcedony which separates them from the silicious limestone of the matrix and indicates a distinct change in the conditions of deposition of the silica between the two formative periods. A series of minerals was collected from Batchellerville, Saratoga county, prominent among which is a number of beryl crystals of unusual size; the largest of these measuring 27 inches in height by 10 inches in diameter. These beryl specimens, although not transparent are of a good characteristic green color, are fairly sharp in outline and constitute fine additions to the New York collection of minerals. From the same locality were obtained some unusually large crystals of muscovite which yield on cleavage, plates showing beautiful dendritic inclusions of magnetite and hematite arranged on the structural lines of the muscovite. A number of rose quartz specimens were also collected from Batchellerville, some of which are of a color and transparency suitable for cutting into spheres to show asterism.

An intestering series of specimens of titanite, associated with fluorite, was collected from Fine, St Lawrence county.

PALEONTOLOGY

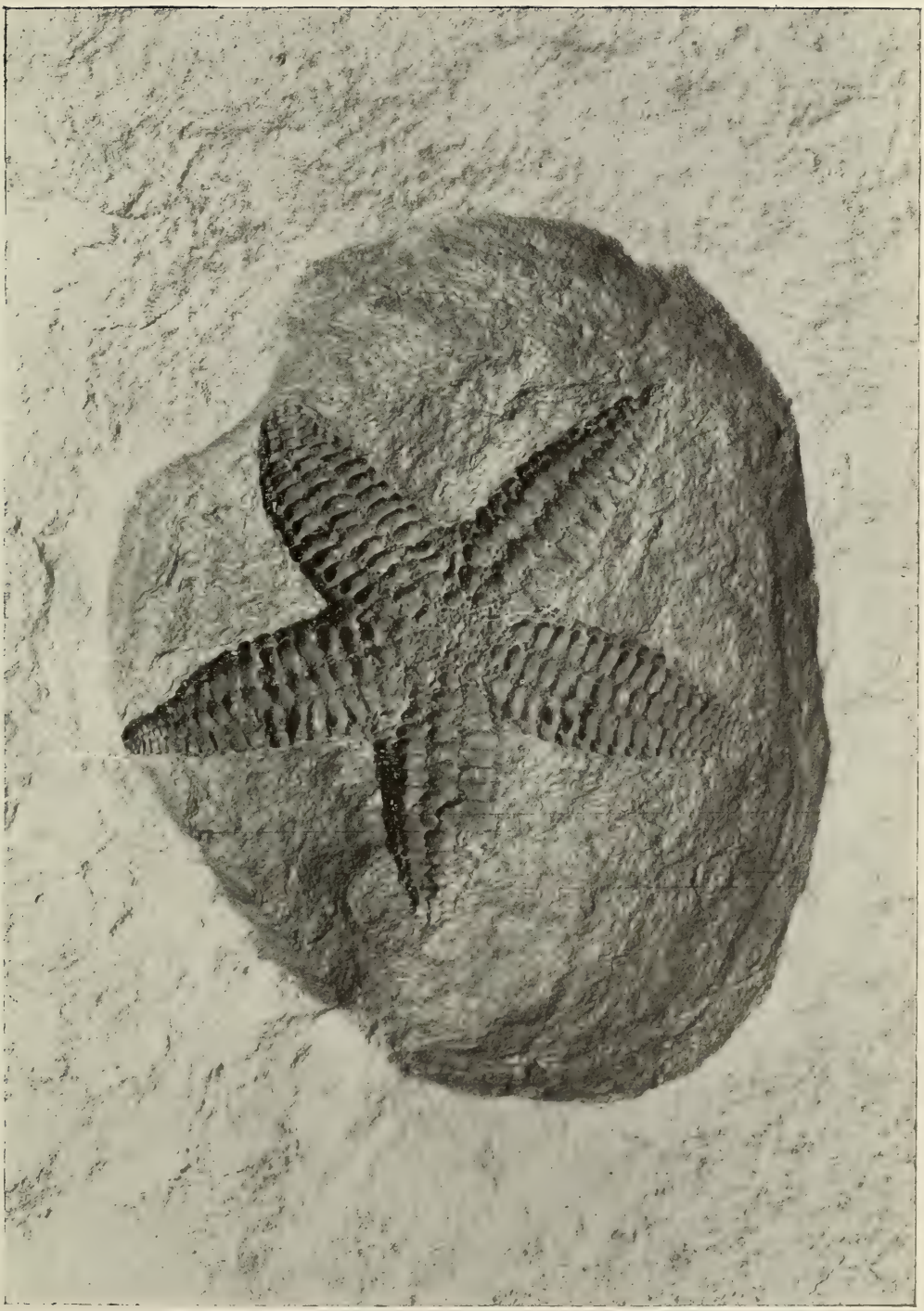
The collection of invertebrate fossils has been augmented by several interesting and valuable acquisitions from the field. Among these is an extensive series of the *Devonic fishes* from the beds at Migouasha in the Province of Quebec. In my report of last year I gave some special attention to the stratigraphy of these remarkable beds which probably surpass in the abundance and perfection of their remains any other known locality of Devonic fishes. An experienced collector has been engaged to watch the natural outcrops which are so exposed to the sea and weather as to break down readily and thus afford a continuous supply of the fossils. Some of the specimens thus acquired have been of a quality and interest to justify brief notice here, and there is given elsewhere in this report notice and illustrations of certain remarkable specimens prepared by Dr L. Hussakof.

The investigations of the *anatomy and distribution of the Eurypterida* to which of late years I have had occasion to make frequent reference have led to a final search for their remains in rocks of the State. The old and historic localities in Herkimer county have again been examined. Last year it was found desirable to remove part of the cellar walls of a barn near Crane's Corners, the rocks of which had been taken long ago from Eurypterus-bearing outcrops now no longer productive. That experience was attended with such success as to justify this year the removal of the remainder of this cellar wall, from which several hundred examples of these interesting creatures have been obtained. Further search for these remains in other parts of the State has revealed them in formations where they were least expected — in the Frankfort shales of the lower Mohawk valley and in the still earlier Normanskill horizon near Catskill. These have been discoveries of high paleontological significance and though the material from these earlier beds has not the superior preservation of the later examples, it has widely extended our knowledge of the history of the arachnid group to which the animals belong.

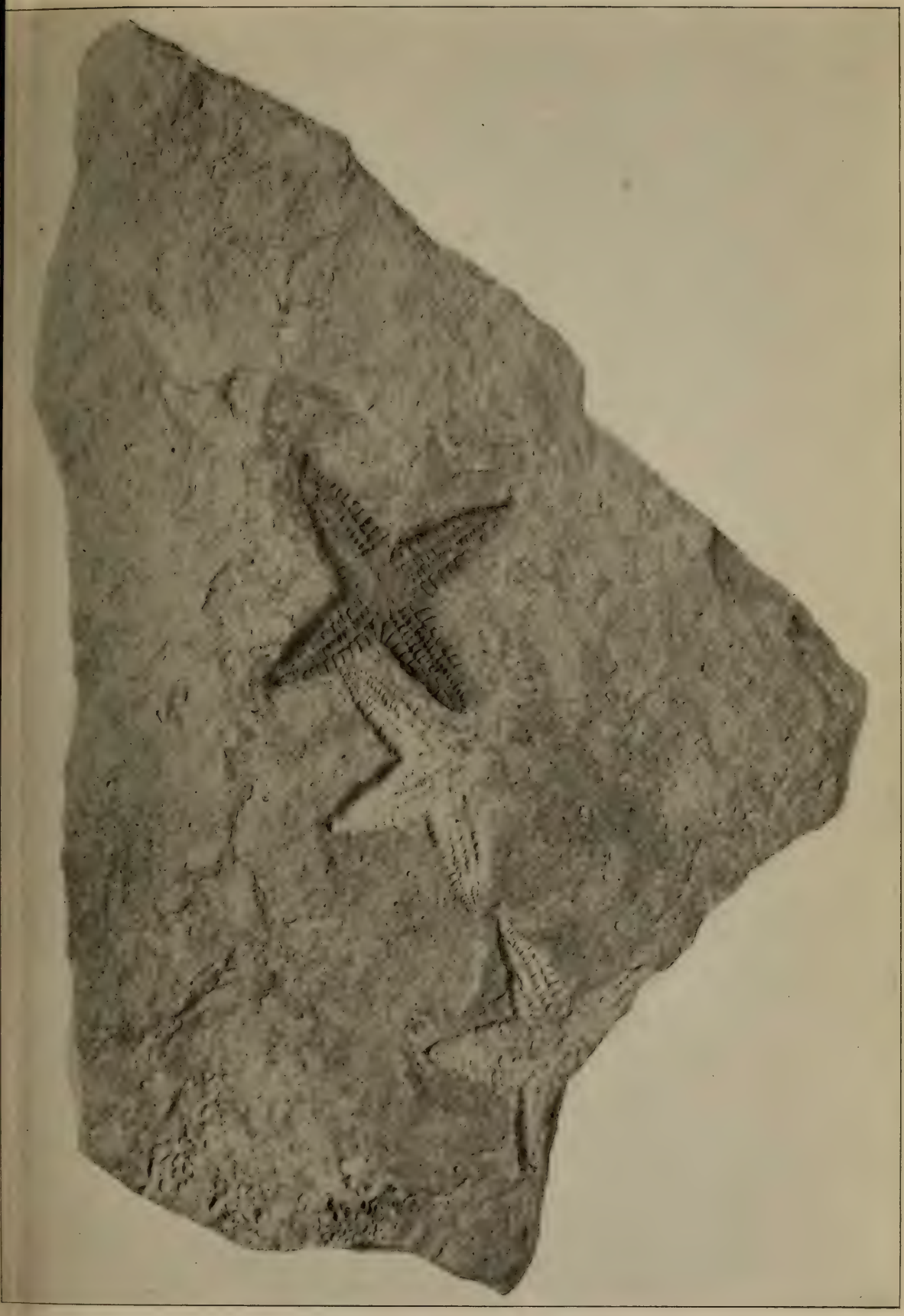
The explorations for these eurypterid remains in late years have been very fruitful and these accessions to our understanding of their geological range and significance, their anatomy and their abundance have been considerations which are fully considered in the monograph of the Eurypterida of New York, a publication which, after years of preparation, is about leaving the press.

A remarkable occurrence of Devonic starfish. The attention of the State Geologist was called to the occurrence of starfish in a sandstone on Mount Marion near Saugerties, through the courtesy of Professor Chadwick and the Rev. Thomas Cole, the discoverer. The sandstone proved to be of Hamilton age and carries some of the brachiopods and pelecypods which characterize that fauna in the central parts of the State. It seemed well to investigate this occurrence. The specimen sent in by the Rev. Mr Cole was a slab which had been broken from a ledge some years before and the locus of this outcrop was no longer known. Mr H. C. Wardell of the staff entered this field and after some days of search on the slopes of Mount Marion and of careful uncovering of concealed ledges, succeeded in finding the starfish-bearing rock. He then proceeded, with adequate assistance, to strip the layer bare and eventually uncovered an area of about two hundred square feet of the sandstone surface, this surface being bounded at the sides by slightly sagging crushed zones at which apparently the sandstone was displaced. The excavation was carried into the hill as far as practicable under the increasing overburden. This is a region where the rock layers have been subjected to some appalachian tilting but it is not yet known whether this productive sandstone is displaced beyond reach along the side lines or sags of crushing. From the sandstone layer as thus exposed were taken slabs and smaller specimens bearing not less than four hundred examples of the starfish Palaester eucharis Hall, a species described from the sandy shales of Madison county. It is probable that never before have so many starfish been found in an equal area of rocks of any geological age. Some views of specimens are here inserted to convey a conception of their number as well as of their fine preservation as external and internal casts.

This occurrence is not only noteworthy for the marvelous abundance of the starfish but for the fact that their intimate association with the pelecypods or clams of the fauna not only suggests but seems to demonstrate the fact that the Palaeasters were feeding on the clams at the time they were overwhelmed in these sands. In present seas and existing oyster plantations the starfish is recognized as the most voracious enemy of the bivalves, especially in oyster beds that are free from much indrainage of land water and where the sea keeps to a normal salinity. To the oyster planter of the Long Island shores salvation lies only in eternal vigilance against these depredators and scores of bushels of stars are annually "mopped" from even small oyster fields. The mode of attack by the starfish on the

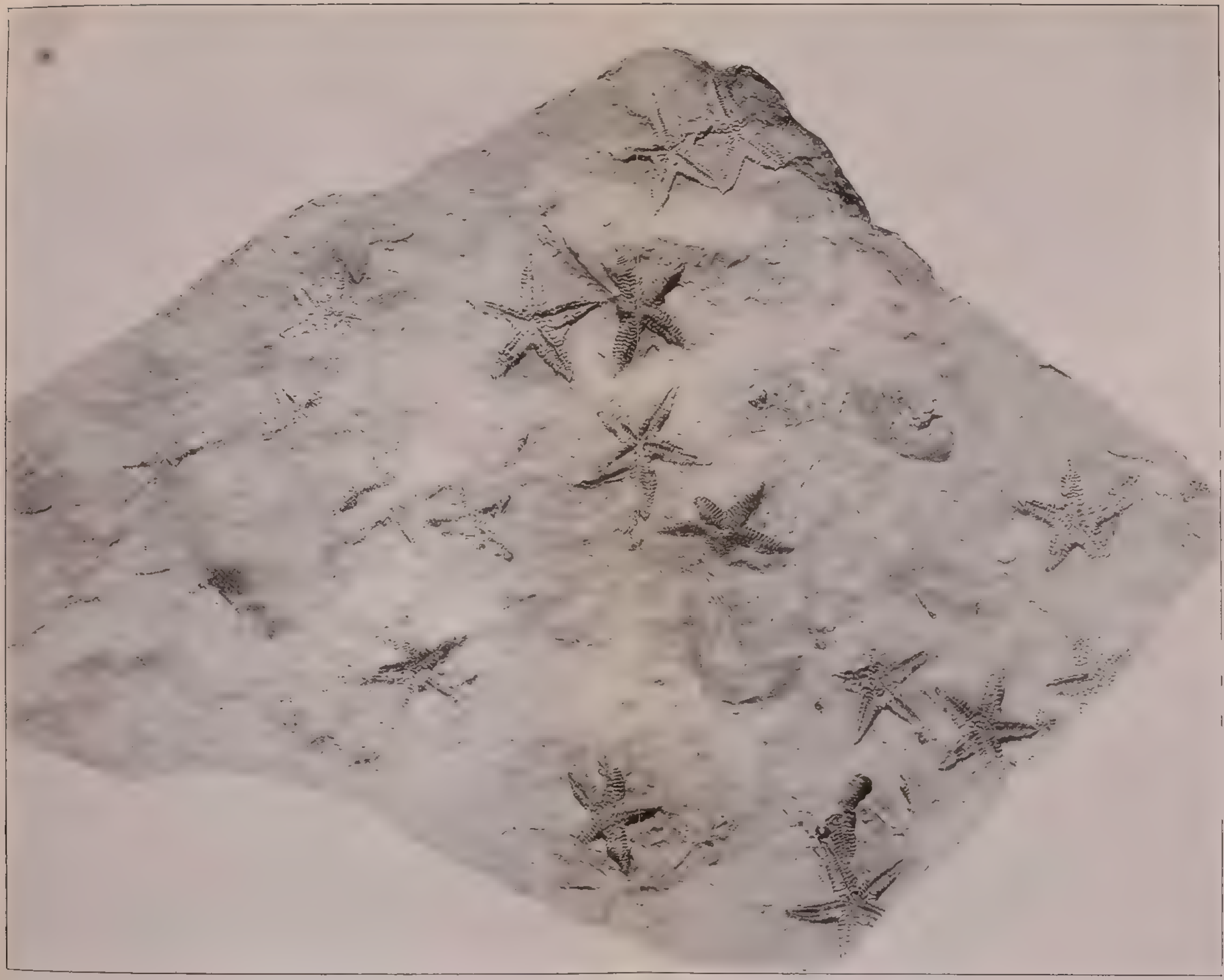


Palaeaster lying within a valve of Grammysia. Both are casts and the aboral exposure of the starfish indicates that its oral surface was against the inner surface of the clam shell. Hamilton sandstone, Saugerties, N. Y.



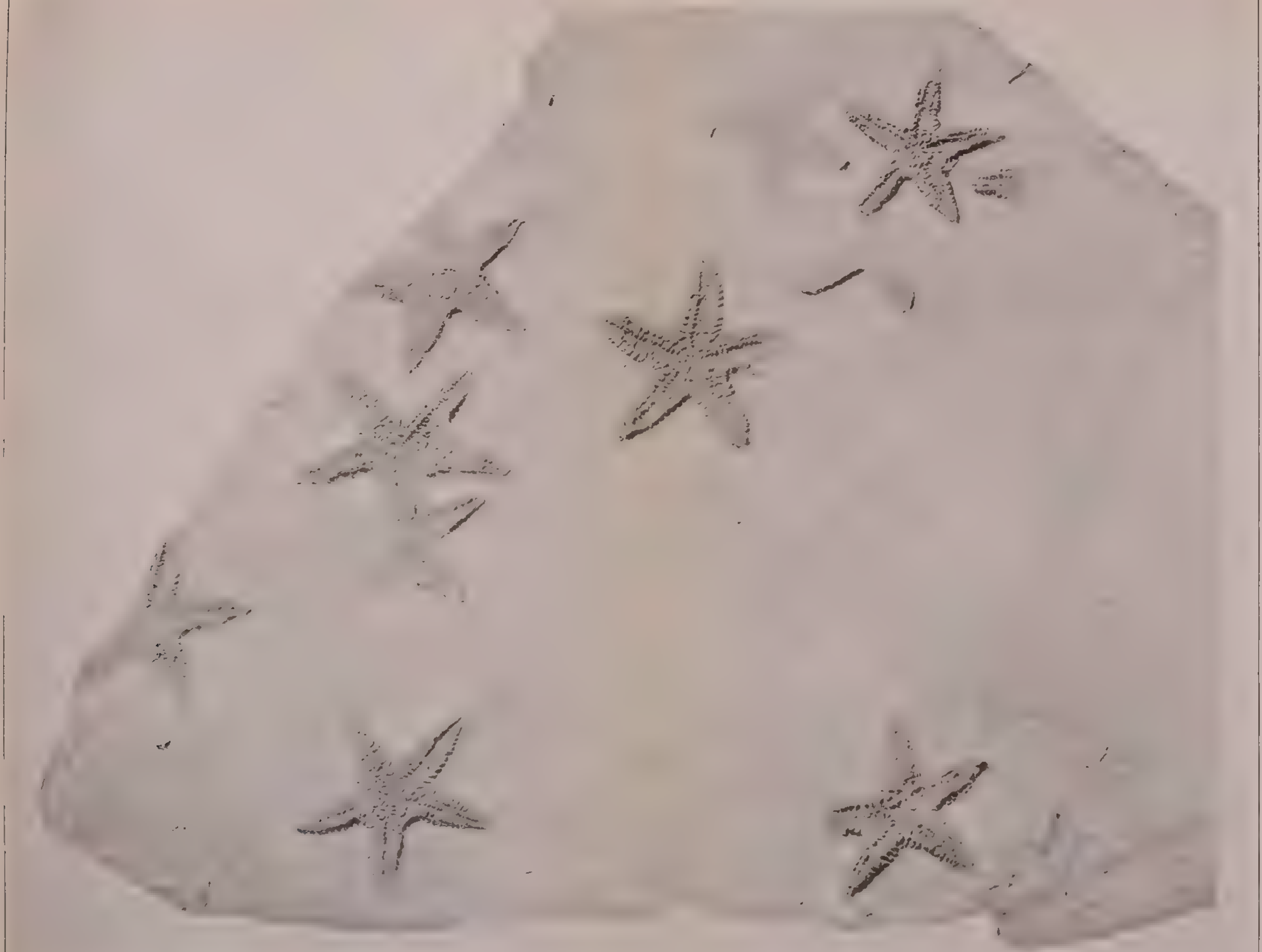
Slab of Hamilton sandstone, much reduced. Showing three specimens of Palaeaster eucharis Hall, one of which has but four arms. Mount Marion, Saugerties, N. Y.

Part of a sandstone slab with valves of Grammysia and Pterinea in such close association with the starfish Palaeaster as to indicate the attack of the latter upon the clams. Hamilton group, Saugerties, N. Y.



A slab of Hamilton sandstone with remains of 20–25 individuals of Palaeaster eucharis Hall. Shells of Grammysia and Pterinea are visible at the side and near the middle of the slab. Saugerties, N. Y.

This slab of Palaeasters shows one lying within the hinge region of a Grammysia. Parts of other pelecypods are scattered over the rest of the rock in association with starfish. Saugerties, N. Y.



Slab of starfish (Palaeaster eucharis Hall). All exposing the oral surface. Reduced. Saugerties, N. Y.

oyster is now pretty well understood. Embracing the oyster with its flexible arms and placing its mouth against the edges of the valves it attaches itself by its suckerlike tube feet to one valve and the other, slowly but persistently and patiently pulling in opposite direction and against the strong pull of the bivalve's adductor muscles which hold the valves together. The slow long pull of the starfish tires out the stronger but less enduring oyster, the valves gradually yield and the incolant falls an easy victim to the eversible gorge of the starfish. A plantation of oysters is an invitation to the starfish to assemble on the ground, but their omnivorous appetite does not restrict them to this viand alone. Nothing edible is foreign to them. So in the ancient days of the Devonic, the clams and oysters, represented by the abundant Grammysias and Pterineas in these rocks, seem to have drawn the stars to this place, and then they were caught. Nearly every Grammysia or Pterinea found in this layer has a star in or on it, sometimes several about its edges in attitudes suggestive of attack and it is altogether reasonable to believe that the hostility between the starfish and the bivalves had fully developed at this early day in the history of the earth.

The structure, internal and external, of the Palaeaster is admirably preserved in these examples and among the specimens are a few which show the existence of only four, instead of the normal five arms.

Fauna of the Snake Hill beds. The organic contents of this formation have been worked out by Doctor Ruedemann and on the basis of their nature he allocates the formation to the lower Trenton The fauna is found in excellent development in shales, grits and cherts along Saratoga lake, and its composition indicates its affiliation with the eastern or Atlantic fauna of this time, rather than with the fauna of the interior basin of the continent.

The nature of this faunal assemblage is indicated by this list of species:

Dicranograptus nicholsoni Hopkinson
Diplograptus amplexicaulis Hall
D. amplexicaulis var. pertenuis Ruedemann
D. (Mesogr.) putillus Hall
Climacograptus scharenbergi Lapworth
C. spiniferous Ruedemann
Cryptograptus tricornis Carr. mut. insectiformis Ruedemann
Lasiograptus eucharis (Hall)
Glossograptus quadrimucronatus Hall mut. pertenuis Ruedemann
Corynoides calicularis Nicholson
Dawsonia campanulata Nicholson

Glyptocrinus sp.
Heterocrinus ? gracilis Hall
Cremacrinus sp.
Schizocrinus nodosus Hall
Carabocrinus cf. radiatus Billings
Edrioaster saratogensis nov.
Pontobdellopsis cometa Ruedemann
Paleschara ulrichi nov.
Pachydictya acuta (Hall)
Lingula curta Conrad
Leptobolus insignis Hall
Pholidops subtruncata Hall
Schizocrania filosa Hall
Plectambonites sericeus typus (Sowerby)
Plectorthis sp. cf. whitfieldi (N. H. Winchell)
Dalmanella testudinaria (Dalman)
Plaesiomys retrorsa (Salter)
Plectorthis plicatella Hall
Platystrophia biforata (Schlotheim)
Rafinesquina alternata (Emmons)
Clitambonites americanus (Whitfield)
Rhynchotrema inequivalve Castelnau
Parastrophia hemiplicata Hall
Cyclospira bisulcata (Emmons)
Zygospira recurvirostris (Hall)
Whiteavesia cincta nov.
W. cumingsi nov.
Orthodesma ? subcarinatum nov.
Whitella elongata nov.
Clidophorus ventricosus nov.
C. foerstei nov.
Ctenodonta levata (Hall)
C. declivis nov.
C. prosseri nov.
C. radiata nov.
C. recta nov.
C. subcuneata nov.
Lyrodesma schucherti nov.
Solenomya ? insperata nov.
Cuneamya acutifrons Ulrich
Archinacella orbiculata (Hall)
Cyclonema montrealense Billings
C. cushingi nov.
Clathrospira subconica Hall
Protowarthia cf. cancellata (Hall)
Pleurotomaria cf. lenticularis (Hall)
Murchisonia (Lophospira) uniangulata var. abbreviata Hall
Orthoceras tenuitextum (Hall)
O. lineolatum (Hall)
Spyroceras bilineatum (Hall)

Conularia trentonensis Hall
Pterotheca cf. canaliculata (Hall)
Eoharpes ottawaensis (Billings)
Trinucleus concentricus (Eaton)
Proëtus undulostriatus (Hall)
Triarthrus becki Green
Isotelus gigas Dekay
Acidaspis trentonensis Hall
Calymmene senaria Conrad
Pterygometopus callicephalus (Hall)
Ctenobolbina ciliata (Emmons)
C. ciliata var. cornuta Ruedemann
C. subrotunda Ruedemann
Lepidocoleus jamesi (Hall & Whitfield)
Turrilepas ? filosus Ruedemann
Pollicipes siluricus Ruedemann

Relation of the Portage fauna of western New York to that of the Domanik shales of Southern Timan in northeastern Russia. In my various papers which have been devoted to the discussion of the Portage (Naples) fauna and its distribution in western New York, there has been frequent occasion to point out the striking similarity between this very peculiar association of fossils and that found in the "Domanik" of northeastern Russia. My first references to this similarity date back some twenty years but these were based wholly on what had been made known of that distant region by Count von Keyserling who explored it in 1843 and published his account of the rocks and their fossils in 1846. Keyserling indicated the similarity in a very broad way but at that time the New York Portage fauna was not well understood from the brief account of it given by James Hall in 1843, nor was the Timan fauna itself comprehended until the materials brought in by the expedition to that country in 1899–1900, had been studied. While I was engaged in describing the cephalopods of the Naples fauna in detail (Naples Fauna of Western New York, part 1), Holzapfel was working out the cephalopods of the Domanik fauna and the two works appeared almost simultaneously, neither writer thus having the benefit of the other's observations. In part 2 of the writer's work under this title, there was occasion to refer at length to the remarkable similarities in the two faunas as indicated by Holzapfel's investigations. Although the remaining molluscan fauna of the Domanik beds was then but very partially known I indicated the very close similarities of these distant faunas, based on the evidence so far as then brought out.

During the year 1911 the lamellibranchs of the Domanik have been elaborated in detail by A. Zamjatin (Die Lamellibranchiata des Domanik: Mémoires du Comité Géologique. n. sér. livr. 67. 1911) and the very peculiar genera and species which compose this element of the Naples fauna, many of the genera not heretofore recognized outside of this assemblage in New York, have proved to be present in the fauna of the Domanik. There is a remarkable community of species which is supplemented by approximations to identity in other cases, all tending to show that the extraordinary similarity in the faunas indicated by Holzapfel's and my own studies of the goniatites is even surpassed by the agreement among the bizarre types of lamellibranchs. Lists of these species as they occur in these two regions are here inserted. The New York fauna appears to be much the more profuse but it is very probable that this fact is due to the more extensive collecting and longer study that have been devoted to it.

PORTAGE, NEW YORK (NAPLES FAUNA)	DOMANIK SHALES TIMAN, RUSSIA
Lunulicardium acutirostrum *Hall*.....	Lunulicardium sp.
L. ornatum *Hall*	
L. libum *Clarke*	
L. wiscoyense *Clarke*	
L. accola *Clarke*	
L. clymeniae *Clarke*	
L. eriense *Clarke*	
L. hemicardioides *Clarke*	
L. furcatum *Clarke*	
L. velatum *Clarke*	
L. finitimum *Clarke*	
L. sodale *Clarke*	
L. encrinitum *Clarke*	
L. pilosum *Clarke*	
L. bickense *Holzapfel*	
L. absegmen *Clarke*	
L. enode *Clarke*	
L. parunculus *Clarke*	
L. beushauseni *Clarke*	
L. suppar *Clarke*	
L. (Opisthocoelus?) transversale *Clarke*	
Pterochaenia fragilis (*Hall*).....	Pterochaenia fragilis (*Hall*)
P. fragilis (*Hall*) var. orbicularis *Clarke*	P. fragilis var. orbicularis *Clarke*
P. sinuosa *Clarke*	
P. perissa *Clarke*	
P. elmensis *Clarke*	

P. cashaquae *Clarke*	P. cashaquae *Clarke*
Honeoyea erinacea *Clarke*	P. timanica *Zam.*
H. major *Clarke*	P. tschernyschewi *Zam.*
H. styliophila *Clarke*	
H. simplex *Clarke*	
H. desmata *Clarke*	
Paraptyx ontario *Clarke*	Paraptyx uchtensis *Zam.*
Actinopteria sola *Clarke*	P. sp. n. *Zam.*
Leptodesma cf. rogersi *Hall*	
Posidonia attica (*Williams*)	
P. mesacostalis (*Williams*)	Posidonia mesacostalis (*Williams*)
P. venusta Münster var. nitidula *Clarke*	
Kochia ungula *Clarke*	
Loxopteria dispar *Sandberger*	
L. laevis *Frech*	
L. vasta *Clarke*	
L. intumescentis *Clarke*	
L. corrugata *Clarke*	
Ontaria suborbicularis (*Hall*)	Ontaria suborbicularis (*Hall*)
O. concentrica (*v. Buch*)	O. cf. concentrica (*v. Buch*)
O. pontiaca *Clarke*	
O. accincta *Clarke*	
O. clarkei (*Beushausen*)	O. cf. clarkei (*Beushausen*)
O. affiliata *Clarke*	O. tchernyschewi *Zam.*
O. halli *Clarke*	O. elegans *Zam.*
Euthydesma subtextile *Hall*	O. articulata (*Münster*)
Elasmatium gowandense *Clarke*	
Buchiola retrostriata (*v. Buch*)	Buchiola retrostriata (*v. Buch*)
B. ? livoniae *Clarke*	
B. scabrosa *Clarke*	B. scabrosa *Clarke*
B. halli *Clarke*	B. halli *Clarke*
B. conversa *Clarke*	
B. angolensis *Clarke*	
B. lupina *Clarke*	B. cf. lupina *Clarke*
B. cf. prümiensis *Steininger*	
Paracardium doris *Hall*	
P. delicatulum *Clarke*	
Praecardium vetustum *Hall*	
P. duplicatum (*Münster*)	
P. multicostatum *Clarke*	
Conocardium gowandense *Clarke*	Modiella aff. pygmaea *Hall*
Palaeoneilo constricta *Conrad*	
P. petila *Clarke*	
P. muricata *Clarke*	
P. brevicula *Clarke*	
P. linguata *Clarke*	
Leptodomus interplicatus *Clarke*	
L. multiplex *Clarke*	

The author we are citing speaks of other identities in these remote

faunas which will come to light as the Domanik material is more fully elaborated.

It is one of the noteworthy facts of our geological history that this singular Devonic fauna, in New York quite free of complications with its predecessors and successors, characterized by very peculiar organic types, should find its most exact reproduction, under like conditions of sedimentation, in the almost antipodean region of the Domanik, separated from New York by 129° of longitude.

III

REPORT OF THE STATE BOTANIST

Since the date of my last report specimens of plants not before represented in the State herbarium have been collected in thirty counties of the State either by myself, my assistant or correspondents and contributors. These specimens represent one hundred species and varieties. Many of them are comparatively recent introductions to our flora but are apparently well established. Among the added species are twenty-eight fungi which are considered new or hitherto undescribed species. A list of these species and varieties is subjoined.

New to the herbarium

Acer carolinianum *Walt.*
Aecidium atriplicis *Shear*
Anthyllis vulneraria *L.*
Armillaria pinetorum *Gill.*
Artemisia frigida *Willd.*
A. gnaphalodes *Nutt.*
Ascochyta imperfecta *Pk.*
A. rhei *E. & E.*
Boletus ballouii *Pk.*
Camarosporium maclurae *Pk.*
Centaurea maculosa *Lam.*
Cercospora medicaginis *E. & E.*
Cercosporella terminalis *Pk.*
Clavaria subtilis *Pers.*
Clitocybe fumosa brevipes *Pk.*
C. hirneola *Fr.*
C. sinopicoides *Pk.*
C. splendens (*Pers.*) *Fr.*
C. tuba *Fr.*
C. tumulosa *Kalchb.*
Coniothecium chromatosporium *Cd.*
Coprinus domesticus (*Pers.*) *Fr.*
Coronospora angustata *Fckl.*
Cortinarius albidipes *Pk.*
Cortinarius phyllophilus *Pk.*
C. purpurascens *Fr.*
Coryneum disciforme *K. & S.*
Cytospora rhoina *Fr.*
C. salicis (*Cd.*) *Rabenh.*
Dasyscypha sulphuricolor *Pk.*
Deutzia scabra *Thunb.*
Diplodia spiraeina *Sacc.*
Diplodina medicaginis *Oud.*
Flammula sulphurea *Pk.*
Fusarium pirinum (*Fr.*) *Sacc.*
Ganoderma sessile *Murr.*
Gloeosporium valsoideum *Sacc.*
Gutierrezia sarothra (*Pursh*) *B. & R.*
Gymnolomia multiflora (*Nutt.*) *B. & H.*
Haplosporella ribis *Sacc.*
Hebeloma sinapizans *Fr.*
Helvella capucinoides *Pk.*
Hendersonia grossulariae *Oud.*
Hydnellum peckii *Banker*
Hygrophorus recurvatus *Pk.*
H. sordidus *Pk.*
Leptosphaeria distributa (*C. & E.*)

Marasmius epiphyllus *Fr.*
Melanconis alni *Tul.*
Mycena atroumbonata *Pk.*
M. metata *Fr.*
Naucoria arenaria *Pk.*
Oenothera muricata *L.*
Omphalia offuciata *Fr.*
Ophiotheca vermicularis (*Schw.*)
Peniophora tenuissima *Pk.*
Periconia pycnospora *Fres.*
Peronospora trifoliorum *DeBy.*
Pestalozzia adusta *E. & E.*
P. funerea *Desm.*
P. longiseta *Speg.*
Phacidium lignicola *Pk.*
Pholiota rigidipes *Pk.*
Phoma amorphae *Pk.*
P. bacteriophila *Pk.*
P. leprosa *Pk.*
P. smilacis *B. & J.*
Physcia granulifera (*Ach.*) *Tuck*
Polyporus melanopus *Fr.*
Polysaccum pisocarpium *Fr.*
Psilocybe fuscofolia *Pk.*
P. polycephala (*Paul.*)
Poria pulchella *Schw.*
Ramularia karstenii *Sacc.*
Rubus glandicaulis *Blanch.*
Sagedia cestrensis *Tuck.*
Septoria aquilegiae *P. & S.*
S. dianthi *Desm.*
S. malvicola *E. & M.*
S. mirabilissima *Pk.*
Sphaeronema minutulum *D. Sacc.*
Sphaeropsis amorphae *E. & B.*
S. maclurae *Cke.*
Spongipellis occidentalis *Murr.*
Stagonospora carpathica *Baeuml.*
Steccherinum peckii *Banker*
Steganosporium fenestratum (*E. & E.*)
Stigmina populi (*E. & E.*) *Pk.*
Teichospora trimorpha *Atk.*
Thyridium pallidum *E. & E.*
Tricholoma boreale *Fr.*
T. planiceps *Pk.*
T. subsaponaceum *Pk.*
T. subsejunctum *Pk.*
Trimmatostroma salicis *Cd.*
Uromyces spartinae *Farl.*
Ustilago hypodytes (*Schl.*) *Fr.*
Verbena stricta *Vent.*
Vermicularia hysteriiformis *Pk.*
Volutella buxi (*Cd.*) *Berk.*

Specimens of 183 species and varieties not new to the herbarium have been added. These represent some new form or variety of species already represented or are better specimens than the older ones.

Several species of wild mushrooms have been tried for their edible qualities. Of these eight species and varieties have been approved, and colored figures of natural size and revised descriptions have been prepared. This makes the number of New York species and varieties of edible mushrooms 213. Investigations have been made showing that some edible mushrooms vary decidedly in flavor.

In an effort to locate the chestnut bark disease which has proved so destructive to chestnut trees in some parts of our State, two trips were made, one to Sand Lake, Rensselaer county, and one to Cooperstown, Otsego county. Both of these visits were unsuccessful in finding any trees affected by the disease, though chestnut trees were common in both places.

In June a visit was made to Peacock marsh, near Averyville in Essex county, and a list of the species of flowering plants observed growing on the marsh was made.

The peculiarities of the season have been shown to have a marked influence upon the abundance of the crop of mushrooms and in some species upon the time of their appearance. The drought of summer delayed the appearance of some species till the fall rains came. Then their appearance combined with that of the usual autumnal species made an unusually abundant crop. The influx of specimens sent to the office for identification was never before so large. It necessitated considerable evening work and even a large number of specimens were unavoidably laid aside for future examination. Among the extralimital specimens examined twenty-three new species and varieties of fungi were found and descriptions of them written. Among the most remarkably delayed species is that of the conical morel, which usually appears in May and June. A colony of it was found near Boston, Mass., growing during October and November.

The work of preparing simple revised descriptions of our New York species of certain genera of fungi has been so well received and strongly commended by correspondents who find them very helpful in their mycological studies that it has been continued the past year. The genera Clitocybe, Laccaria and Psilocybe have been treated according to the plan previously followed. The first mentioned genus is one of special difficulty both because of its large number of species, their variability and different appearance at different ages and their close resemblance in many cases to each other. The genus has been divided into several genera by modern mycologists but we have preferred to follow mainly the better known Friesian and Syllogian arrangement. Our New York species as here understood number sixty-four after taking out the few species here placed under Laccaria.

IV

REPORT OF THE STATE ENTOMOLOGIST

The State Entomologist reports the appearance in late May of a large brood of the *periodical Cicada* or so-called *seventeen-year locust*. This was of much popular interest and an entomological event of some importance. A hitherto unknown colony was located near Amsterdam and much learned through the cooperation of many local observers respecting the present distribution and relative abundance of this insect in New York State. A fine series of photographs showing the transformations to the adult was obtained. Despite the warnings of earlier years, a number of young orchard

trees had been set in the vicinity of abundant Cicada colonies and, as a result, were severely injured.

During the period covered by this report, Miastor larvae were discovered by the Entomologist, their biology ascertained in large measure, their amenability to laboratory conditions demonstrated, and owing to the value of this information to teachers, a discussion (illustrated with a series of photomicrographs) of *pedogenesis* in this insect and its allies was included as an appendix to the Entomologist's report for 1910. Subsequent studies have confirmed the observations referred to above and have shown a wide distribution for Miastor.

Fruit pests. The experiments with the codling moth or apple worm were continued in the orchard of Mr W. H. Hart of Poughkeepsie and in those of Messrs Edward Van Alstyne and William Hotaling at Kinderhook. Special pains were taken to secure uniform plots of ample size and to see that the treatment was thorough. Each plot, as last year, except in the case of Mr Hotaling's orchard, consisted of forty-two trees, the fruit from the central six alone being counted. The relative value of one, two and three sprayings, and also of one application made three weeks after the blossoms dropped, was ascertained. The results compare closely with those obtained in 1909 and go far to show that the conditions in 1910 were exceptional. One thorough application last season resulted, in the case of trees bearing a fair crop, in from over 98 to more than 99 per cent of worm-free fruit. This should prove most encouraging to the fruit grower, since the work was done under practical conditions which can be duplicated in almost any section. Assistant Entomologist Young assisted in the field work, classified the wormy fruit and computed the tabulated data.

The work of 1911 with the *codling moth* has been correlated with that of the two preceding years and affords the most comprehensive data yet secured as to the possibilities with one spraying under varied conditions. These results should be of practical value in enabling the fruit grower to determine for himself the advisability of spraying more than once in any season.

Observations by the Entomologist show that the *San José scale*, while a serious fruit tree pest, is being generally controlled, though some fruit growers are not entirely successful, in fact due in large measure to difficulties in treatment. Some of the latter are excessively large or inaccessible trees, adverse weather conditions at the time the work should be done or defects in equipment. The con-

centrated home-made or commercial lime-sulfur washes were used largely and mostly with very satisfactory results.

The peculiar linear series of eggs so frequently seen on apple and pear bark have been identified as those of the *notch wing*. The usually rare *Say's blister beetle* was exceptionally numerous. Two small fruit insects, the *raspberry Byturus* and the *garden flea* were studied at Milton, the former proving somewhat injurious.

Gipsy moth. The discovery of a gipsy moth colony at Lenox, Mass., while not entirely unexpected, was something of a shock to our extensive agricultural interests. A personal examination satisfied the Entomologist that the insect was brought there with trees and shrubs purchased a few years ago in eastern Massachusetts. Nothing but the closest inspection and the adoption of most rigid precautions will prevent the early establishment of this pest in New York State. Judged solely from an economic standpoint, there can be no question as to the advisability of keeping this insect out of the State as long as possible. We have assembled during the year a series of preparations designed to facilitate the recognition of this pest in any stage. Several of these have been reproduced as excellent photomicrographs and will be of great service in identifying this species.

The Entomologist visited the territory in eastern Massachusetts infested by this insect and found the residential area, as a whole, in excellent condition though there were extensive tracts of forest land badly infested. The ultimate spread of this pest is inevitable and the Federal authorities have accomplished much in retarding its dissemination by keeping the roadside trees of the principal thoroughfares free from the pests. Marked progress is being made in the work of introducing parasites and natural enemies which it is expected will shortly prove of material service in checking this injurious pest. This however is no justification for not adopting every other reasonable measure for preventing the spread of this destructive caterpillar. The state of Connecticut has made excellent progress in handling its gipsy moth problem.

Brown-tail moth. This species, while not so destructive as the gipsy moth, has become established in Williamstown, Mass. Since both sexes of the moth fly readily, it will probably not be long before this pest appears somewhere in New York State. The winter nests are so characteristic that there should be little difficulty in identifying the insect and at the outset preventing excessive multiplication. Careful inspection of nursery stock should prove an effect-

ive barrier to its being introduced with trees and shrubs. The observations above relating to the parasites of the gipsy moth apply equally to the natural enemies of the brown-tail moth.

Shade tree pests. The Entomologist investigated conditions in a number of communities and found exceptionally severe and widespread injury by the *elm leaf beetle*. The defoliation was so general, in connection with the work of previous years and the severe droughts of earlier seasons, that many trees have succumbed or are likely to die in the immediate future unless radical measures are adopted for their better protection.

There seems to be great difficulty in securing efficient treatment, even if the equipment be adequate. This defect has been pointed out and, with a fuller understanding on the part of those compelled to solve the problem, we look for materially better results another season. The elm leaf beetle is not such a serious pest in Europe, and it would seem, in view of the probable continuance of the severe injury of the last few years, to be due in part at least to changed conditions, as though a serious effort might well be made to secure natural enemies, since they appear to be very effective checks upon this beetle in European countries.

The *cottony maple scale* and the false maple scale occasioned repeated complaints, owing to their effect upon hard and soft maple, especially in the vicinity of New York City. An unfortunate condition developed in the city of Mount Vernon. Several hundred hard or sugar maples were seriously injured or killed, following the application of one of the commercial miscible oils in early spring. An investigation convinced the Entomologist that the trouble was due to the material applied, the injury being greatly aggravated by subsequent cold weather retarding growth and producing conditions favorable for penetration by the oil. We must therefore classify early applications of oily preparations as dangerous to hard maples.

The extended outbreak by the *green maple worm* was investigated and must be partly charged to the general destruction of birds and a consequent scarcity of the insectivorous species. Investigations by Zoologist W. G. Van Name showed that nine species were feeding upon the caterpillars, while seven others were in the vicinity, probably for the same purpose. A relatively slight increase in the number of the birds would doubtless have prevented the defoliation of the trees. The *spiny elm caterpillar* and the *white-marked tussock moth* are two other shade tree pests which were excessively abundant and the subjects of much correspondence. The ornamental birches are

being rapidly destroyed by the pernicious *bronze birch borer,* the depredations of which were detected the past season in the eastern part of the State.

Forest pests. Injuries by insects to forests have greatly increased during recent years. The *hickory bark borer* has destroyed thousands of magnificent trees in the vicinity of New York. The investigations of the Entomologist showed that this nefarious pest had destroyed many hickories at Tivoli. A warning circular was issued and widely copied by the local press. The *two-lined chestnut borer,* probably breeding first in fungus-affected chestnut, invaded nearby oaks at Old Westbury. This outbreak was studied and appropriate repressive measures advocated. Damage by this species was also reported from Garden City. The severe though local injury by the *locust leaf beetles* at Syosset and Jericho received personal attention. The exceptional abundance of the *maple leaf cutter* at Lake George was also investigated.

Flies and mosquitos. General interest has been maintained in the *house fly* campaign. The Entomologist prepared several popular notices and experimented in a limited way with a fly trap. The results with the latter, while beneficial, were not entirely convincing. He investigated a local *mosquito* problem at South Salem and had the satisfaction of learning that the execution of his recommendations resulted in the speedy disappearance of the pests. Many localities in the State are suffering needless annoyance and, in some cases, illness because mosquito breeding pools are ignored. One case came to his notice where malaria developed following the employment of Italians in a locality previously free from this disease.

Gall midges. The studies of the Entomologist in this interesting and important group have been continued as opportunity offered. A number of new species have been reared and described, and a table of food habits of the reared species and a generic synopsis of the entire group published. This family, composed entirely of small to minute flies and including a number of destructive forms, is an immense complex which could be grouped satisfactorily only after prolonged and careful microscopic studies. This has been accomplished and a monographic account of the family is now in manuscript.

Publications. A number of brief popular accounts of the more injurious species of the year were prepared by the Entomologist and widely circulated through the agricultural and local press. His extended contributions, aside from the report for last year, are:

Summary of the Food Habits of American Gall Midges; A Generic Synopsis of the Itonidae; Hosts and Galls of American Gall Midges, and New Species of Itonidae. His more important publications, forty-four in number, are listed in his report, which also contains detailed accounts, with special reference to control measures, of most of the injurious species mentioned above.

Collections. There has been a continued increase in the State collections. Most of the additions the past year have resulted from collections by the Entomologist's staff, some of the most desirable having been reared. Extremely large series of Miastor and Oligarces were obtained in this manner and will be available for exchange later. Specimens illustrating the habits and work of insects are being collected at every opportunity, since they are particularly valuable for economic and exhibition purposes. There have been substantial additions to the gall midges or Itonidae and they are now in very satisfactory condition. The pinned specimens were rearranged by Miss Hartman and this, in connection with the numerous microscopic slides, and the large assemblage of galls and other biological material, will prove invaluable to subsequent workers, especially as the collection includes a very large number of types.

The classification of the diversified material in the Museum and that daily coming to hand is necessarily slow and is a work which must extend over years. There is need of more assistance in carrying on the large amount of labor involved in the amassing of a thoroughly representative collection necessary for the maintenance of an adequate exhibit in the enlarged quarters afforded by the Education Building.

Three additions have been made to the series of plant groups designed for the exhibition of insects in their natural environment in the new quarters. These will add greatly to the attractiveness and pedagogical value of the enlarged exhibit collections now in preparation.

Assistant Entomologist Young has rearranged and identified the Muscidae, the species belonging to the coleopterous genera Telephorus and Podabrus, and has done considerable work on the snapping beetles or Elateridae, the parasitic flies, the Tachinidae, and a group of parasitic wasps, the Braconidae.

Miss Hartman has made nearly five hundred microscopical preparations of various species, mostly gall midges and scale insects, rearranged the pinned collection of scale insects and prepared a

special Cicada exhibit. She also has given much time to mounting, spreading and labeling the specimens.

Nursery inspection. The nursery inspection work conducted by the State Department of Agriculture has resulted in the Entomologist being requested to make a number of identifications and also recommendations in regard to the policy which should be pursued by the State. Most of the material submitted for name is in poor condition, may represent any stage in insect development, and is often from a foreign country. This work, though time consuming and laborious, is important, since the disposition of large shipments must depend in great measure upon his findings. The possibility of introducing the gipsy and brown-tail moths with nursery stock originating in territory infested by these pests, justifies a most careful examination of all such material and the adoption of every reasonable precaution.

Miscellaneous. A series of experiments planned by the Entomologist and conducted for the purpose of testing the value of heat as an insecticide, showed that the relatively moderate temperature of 120° F. is soon fatal to the common black cockroach so frequently seen in warmer parts of dwellings. Buildings equipped with ample heating facilities are adapted to this method of checking household and storeroom pests. Observations were made upon the hibernation and development of the rose leaf hopper. An interesting outbreak by an Iris borer was also investigated. Assistant Entomologist Young had charge of the heat experiments, being assisted in this by Miss Hartman.

The Entomologist, as in previous years, has been called upon to lecture upon injurious insects at farmers institutes, horticultural and other gatherings, information respecting shade tree pests, owing to their serious injuries this year, most frequently being desired.

Office matters. The general work of the Entomologist's office has progressed in a satisfactory manner. The correspondence shows a marked increase over that of last year; 2219 letters, 23 postals, 1014 circulars, 1623 packages were sent through the mails and 42 packages were shipped by express. As heretofore, there has been a most helpful cooperation on the part of all interested in the entomological work of the State.

V

REPORT OF THE ZOOLOGIST

The work of the zoology section has been conducted with regard to the exhibits which are to be expected in the new quarters, and with a view to preparing the collections now in the Museum for removal with as little injury and confusion as possible. Much of the zoological material, especially that which has been on exhibition, is of so fragile a nature that its safe removal can be accomplished only by careful handling and intelligent supervision at the time of moving. It has therefore seemed important to get the material that may be boxed up for handling by the ordinary methods of transportation packed as soon as possible, so that when moving attention may be given wholly to the fragile material. This policy has been consistently carried out during the fiscal year as far as other work would permit, with the result that large parts of the study and duplicate collections are now safely boxed up to stand rough handling and storage for as long as may prove convenient, without danger of injury or further deterioration.

Among other specimens, those that have been thus cared for are the corals (both duplicate and exhibition collections), the Mazatlan and Carpenter collections of shells, the bird eggs (exhibition and study collections), the bird skins, many of the duplicate shells, the bird nests, and most of the disarticulated skeletons and smaller osteological specimens. The majority of these were previously in storage, and though some of the corals and bird eggs were taken from the exhibition cases, the exhibits had not at the end of the fiscal year been so interfered with as to require closing the exhibition rooms to the public.

Incidental to this packing, as well as for the sake of discovering the needs of the Museum in the way of new specimens, and of caring for such specimens as might need it, the Zoologist has thoroughly overhauled the storerooms and storage closets. The bird skins, which on account of the loose construction of the cases in which they had been kept, were in poor condition, have mostly been cleaned, relaxed, and put in first-class condition before packing.

In preparation for the exhibits in the Education Building, the Zoologist has devoted much attention to plans for the arrangement and dimensions of the cases to be ordered, as well as to the details, methods and materials of construction which seem best adapted for the requirements of the Museum. Many of the mounted specimens

in the present collection have been carefully cleaned, and in many cases relaxed and improved or remounted, so that they will remain presentable for many years to come, and the expense and trouble of replacing them with new specimens may be postponed for a long time. To accomplish this, the taxidermist has installed a compressed air cleaning outfit and has made a plaster-lined chest for relaxing specimens, as well as a number of storage chests.

The large amount of work to be done in the Museum has prevented any field work by the staff, but additions to the collection have been made by purchase as far as funds were available, and to a less extent by exchange, or received as gifts. The moose group, consisting of three individuals, previously ordered from Ward's Natural Science Establishment, has been delivered to the Museum and placed in storage. The specimens are fine ones and unusually well mounted. Work on the other large groups ordered has also made progress. In the purchase of new material the want of specimens of the larger birds and animals has been kept in view, both because the collections have been deficient in good specimens of them and because of the importance of rendering the Museum interesting and attractive to the general public at the time of opening, and of adequately filling the large exhibition space.

Among the more generally interesting specimens acquired should be mentioned the materials (mounted young and old birds, nests, eggs and accessories) for arranging nesting groups of the larger and more conspicuous birds that breed in New York State, purchased from Mr S. H. Paine of Silver Bay, and Mr Fred Barker of Parker's Prairie, Minn., a group of opossums consisting of the mother and nine young, also some casts and models of reptiles and small cetaceans (porpoises and dolphins) from Ward's Natural Science Establishment, and several fine elk skins suitable for mounting, from Rhodes and Gilbert of Lander, Wyoming. In the material acquired this Museum has the basis of exhibits which will be hard to duplicate in view of the increasing rarity of many of the species.

Monograph of the New York Mollusca. Dr H. A. Pilsbry has continued his work on this subject and reports that the land mollusks are now completed in manuscript and good progress has been made on fresh water forms. The land snails have required very special attention for the reason that great progress has been made here and abroad in classification during the last twenty years, while there has been no critical examination of our northeastern fauna since Mr

Binney's work of 1878 (his Manual of 1885 being merely a reprint). This has necessitated considerable work in dissecting eastern forms to settle their generic affinities by the new standards. Much of this work has application far beyond the limits of New York and will thus give the report a wider than local interest. The examination of collections has added several species to the fauna, but a number reported from the State have been deleted, as they were found, when the specimens were traced, to be erroneous identifications. A few others reported from "Western New York" in reputable works still need verification.

VI

REPORT ON THE ARCHEOLOGY SECTION

The work of this section divides itself into two subsections, archeology and ethnology. In turn, these again divide into several distinct branches. To carry out the plans of the section the work involves both time spent in the field and in the office. Besides these various divisions of research and of labor, the work of the fiscal year just past has been divided between that necessary to carry on the ordinary requirements of the section and the special requirements of the Myron H. Clark Hall of Iroquois Ethnology. The additional labor brought about as the result of the Capitol fire and the destruction of the archeological and ethnological collections exhibited about the western staircase, has been heavy and consumed much of the time between March 29th and May 15th.

With a great increase in the correspondence of the section, together with the other work, activities have been taxed to the utmost.

Archeology. During the autumn of last year an interesting site was located in the town of Livonia, Livingston county. It was one of several examined during the year and found worth excavating. The site has long been known as that of a fort or village of the colonial period. The burial ground had not been found until located by our tests.

During July, August and September fifty-two graves were found and explored with good results. The graves presented some interesting problems and yielded some interesting and unique specimens. The excavations were conducted by Mr E. R. Burmaster, who for several years has acted as field assistant and whose expert services this year did much to bring about successful results.

A peculiar feature of the Lima site is that most of the graves were stoned up, but they did not resemble the stone graves of the pre-Iroquois culture, being deeper and not so well constructed. The poor condition of the skeletons and the broken pots were a result of poorly placed top slabs, which falling in had crushed the contents of the graves.

Only twelve of the fifty-two graves contained male skeletons. The few male skeletons which were found were of cripples or of aged men, none being of the warrior class. The females showed evidences of a hard life, there being broken bones and indications of osseous diseases, such as rheumatism and ankylosis. Ten of the skeletons lay on the right side, one of these being an infant in its mother's arms. One skeleton, also that of an infant, lay face up, the indications being that it had been buried in a cradle board. All the other forty-one skeletons were on the left side. There seemed to be no special orientation in the direction of the face or head, every point of the compass being used. The position of the body was uniformly (except in the case of one infant already mentioned) flexed, that is on the side with the legs bent and the knees drawn up toward the chest.

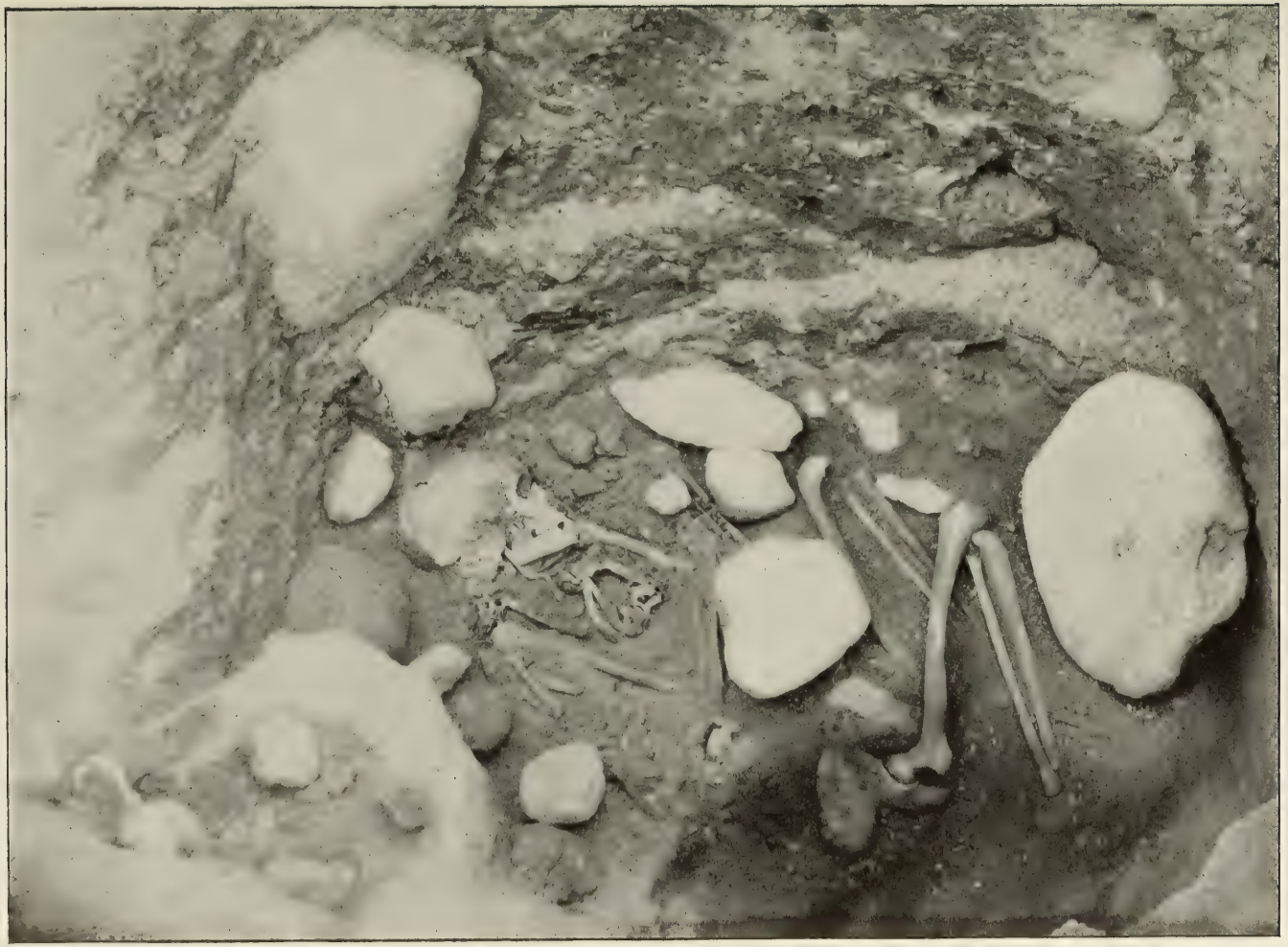
The age of this site is manifestly of the early colonial period, sheet brass having been found. That the period was rather early is shown by the fact that there were no brass kettles; all the European metallic material had been beaten up into ornaments. There were only a few glass and early trade wampum beads.

The burial site adjoined a village stronghold on the edge of a low bluff made by the intersection of two stream channels; one an ancient glacial stream or lake, now entirely filled by gravel or peat, and a more modern stream which as a small brook is still running.

The village site was only superficially examined because it is covered with a clover meadow valuable to the owner. The pits which were examined showed the usual bone and flint material with an occasional piece of metal and the columella of a sea shell.

By comparing the data of the graves of this site, that is those in the section examined, the Archeologist concludes that the burials are those of captives or slaves. Later investigations, however, may modify this conclusion.

The Archeologist and the members of the expedition are much indebted to the various members of the Livingston County Historical Society for assistance and other support in pursuing their investigations and surveys throughout the county. It is a source of much



Typical burial at the Lima site. Early colonial contact period.

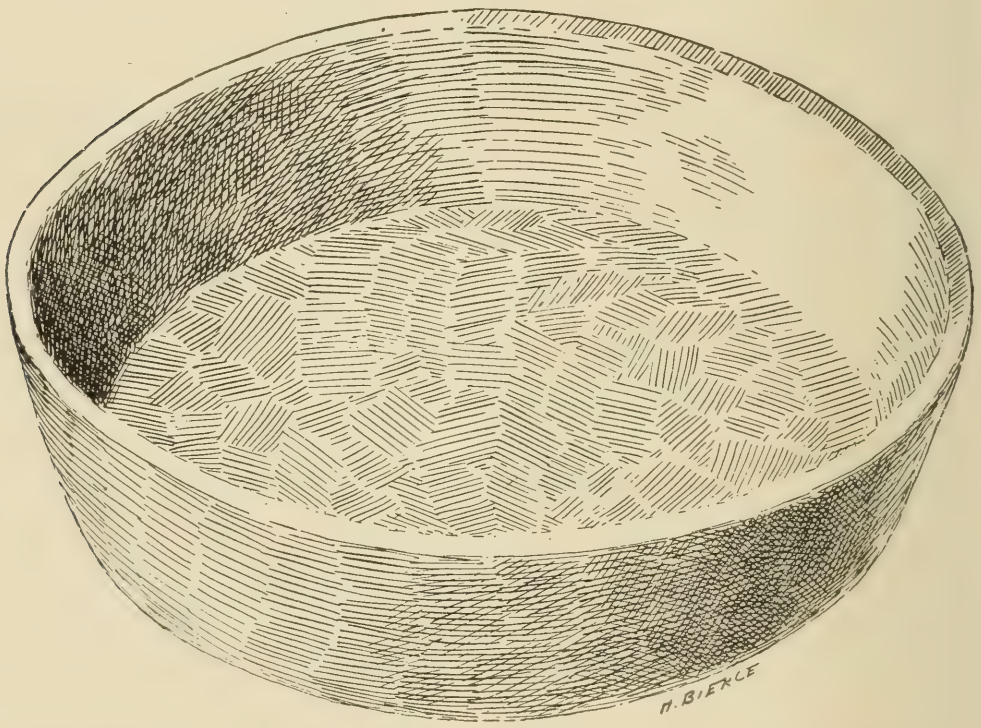
Seneca burial found at Lima, 1911. The stone lay over and had crushed the head. Many bone implements were found in this grave.

gratification to find so many persons willing to cooperate in a work of this kind. We are under obligation to many for information and for their personal services as guides throughout the county.

Pending a more complete report of the season's work the following summary of the excavations at Lima is given:

BURIAL NUMBER	Depth	Dimensions	Face	Head	Side	Position	Sex	Condition	Objects in grives
1.....	28″	44x36″	N E	S W	left	flexed	M	crushed	broken pot, bracelet
2.....	44	48x42	E	S	L	"	F	skull c	none
3.....	28	48x42	S	E	L	"	F	skull c	brass spiral, wampum
4.....	30	42x36	N E	N W	L	"	F	skull c	none
5.....	30	48x36	N	W	L	"	F	skull c	none
6.....	40	48x28	N	W	L	"	F	good	shell beads, copper tube stone dice, etc.
7.....	36	42x30	N	W	L	"	M	poor	none
8.....	24	42–38	S	E	L	"	F	fair	bone comb, flints, etc.
9.....	50	50x36	N E	N W	L	"	M	fair	7 flint points
10.....	24	36x36	N	W	L	"	..	fair	4 copper rings
11.....	24	48x38	N E	N W	L	"	M	fair	2 flint points
12.....	24	54x26	N	W	L	"	M	fair	none
13.....	26	44x36	N E	N W	L	"	F	good	broken pot
14.....	42	48x36	N	E	R	"	M	fair	3 turkey mandibles
15.....	26	44x22	S	E	L	"	M	fair	none
16.....	36	36x22	E	N	L	"	F	fair	none
17a.....	36	48x32	S	E	L	"	F	fair	bone ornament
b.....	36	48x32	....	....	.....	"	Inf.	.....	
18a.....	30	36–22	up	W	on back	exten.	F	poor	none
b.....	....	.....	....	....	"	....	Inf.	.....	
19a.....	34	52x36	....	....	L	flexed	F	fair	none
b.....	....	.....	....	....	.....	"	F	.....	
20.....	48	39x28	N	W	L	"	F	poor	none
21.....	42	.....	N	W	L	"	F	fair	brass bracelets, beads, metal, shell, stone dice
22.....	48	45x32	S	E	L	"	M	fair	bone punch, arrow heads, flint chips, etc.
23.....	42	38x42	S	E	L	"	Inf.	poor	nothing
23a.....	37	42x26	N W	S E	R	"	F	poor	nothing
24.....	41	48x36	N	E	R	"	F	fair	necklace and armlet of shell beads
25.....	30	24x20	S	W	R	"	Inf.	poor	none
26.....	....	42x29	W	S	L	"	F	poor	none
27a.....	....	.....	N	....	R	"	F	fair	wampum and shell bead necklace, horn beads, brass rings attached
b.....	48	52x36	S	E	L	"	Inf.	poor	
28.....	....	.....	S	W	R	"	M	fair	3 antler punches, 3 bone awls
29.....	52	48x32	S	W	R	"	F	fair	3 clam shells, flint chips
30.....	34	50x32	N	W	L	"	F	fair	none
31.....	58	36x23	E	E	L	"	M	.....	none
32.....	41	44x32	S	E	L	"	F	poor	none
33.....	36	44x36	W	S	L	"	F	fair	none
34.....	52	33x38	S	E	L	"	..	good	none
35.....	42	48x37	....	....	.....	"	..	poor	none, only few traces of bone
36.....	41	28x26	E	S	R	"	..	poor	crushed pottery vessel
37.....	34	38x25	S W	N W	R	"	F	fair	none
38.....	42	26x16	N	W	L	"	..	poor	none
39.....	48	28x23	N	W	L	"	Inf.	fair	brass spiral, shell beads
40.....	34	44x30	W	S	L	"	F	fair	broken pot
41.....	34	48x32	N	W	L	"	M	fair	broken pipe, eagle bones
42.....	52	46x38	E	S	R	"	F	fair	1 glass bead
43.....	41	26x20	W	S	L	"	Inf.	fair	none
44.....	35	50x36	N	W	L	"	M	fair	none
45.....	48	48x31	S E	N W	R	"	M	fair	none
46.....	38	22x19	W	S	L	"	Inf.	fair	none
47.....	42	39x30	S	W	R	"	F	fair	none
48.....	37	36x29	N	W	L	"	F	poor	none

Ethnology. The Museum is still fortunate in being able to acquire occasionally good ethnological material from the Indians of the State and during the year a number of fine specimens have been added to our collections. The sources are already being exhausted by the many who are interested in Iroquois ethnology. As long as the Indians in New York remember the articles characteristic of their native culture, however, it is possible to have specimens made by them to illustrate the old form. This is especially necessary in the case of costumes.



Council gambling bowl of the Tonawanda Seneca. Collected by A. C. Parker, 1911

During the summer the council dice-bowl of the Tonawanda Seneca was secured. It is an ordinary maple gambling bowl such as the Senecas have long used but nevertheless an interesting specimen. It is some ten inches in diameter and four inches deep on the outside though the inside measures three. At present it forms the only specimen in the Museum, all others having been destroyed in the Capitol fire.

A number of baskets have been added to the collection. Two are of special interest in the matter of weave and decoration. The use of different colored splints for standards has produced a design similar to the Cherokee split cane basket of North Carolina. The

baskets were collected at the Tonawanda reservation but had been made by an Oneida woman.

A good assortment of silver articles was collected. This includes two sets of bracelets or arm bands. These interesting products of Iroquois silversmithing add materially to our already extensive collection.

A unique acquisition is a set of decorator's tools from the Tonawanda reservation. The set consists of fourteen pieces of which six are swab brushes, six pointed markers (the reverse ends of three being stamps for round spots), three forked for drawing parallel lines, three double forked for making four dots, one horse hoof stamp and one dipping rod for removing splints from dye. The rods are about eight or ten inches long and the swab brushes and pointed sticks taper from the size of a pencil at the large end to an eighth or even a thirty-second of an inch at the smaller end. The outfit is a simple one and was used by a basket maker for decorating baskets, bows and canes. Certain features about the tools suggest that they follow an earlier type and are similar to those which had been in use in earlier times.

Peach stone dice. Natural size. Tonawanda Seneca. Collected by A. C. Parker, 1911

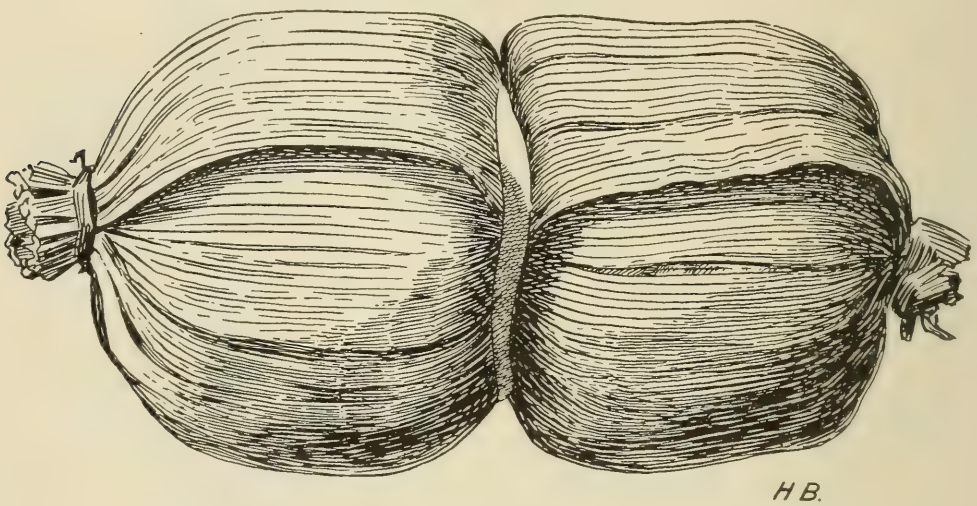
Ethnological studies. During the year just passed the studies of the Iroquois ceremonial rites and cults have been continued, resulting in the addition of new and interesting material.

Of special interest are the many additional notes on the laws of the Five Nations Confederacy. The Archeologist was fortunately able during evenings and holidays to record much of value from the lips of a number of Indians versed in the old-time lore. The manuscripts already on file were annotated in the field and examined critically by various authorities among the Indians themselves.

The Code of Ga-nio-daio was again gone over by Chief So-son-do-wa (Edward Cornplanter) and changes were made at his sug-

gestion. The manuscript in question is Cornplanter's own translation of the "New Religion" of the Six Nations. Cornplanter is one of the five or six "ha-djes-ta-dje" who are familiar with the teachings of the prophet Handsome Lake, or Ga-nio-daio as he is known to the Seneca. The changes made were certain corrections of names and small additions to the text.

The second lengthy manuscript is one compiled by the Archeologist from the various versions of the Iroquois Ga-ya-nes-sha-go-wa, or "Great Binding Law." The Iroquois refer to this as "the constitution" and indeed both Morgan and Hall refer to it by this term.



Seneca "wedding" bread. Collected 1910

It purports to be the laws given by Dekanawideh, the Iroquois culture hero, and embraces also a narrative of the lives of both Hai-yent-wa-tha (Hiawatha) and Dekanawideh. Its special interest lies in the fact that it is an attempt of the Iroquois themselves to explain their own social system. It is therefore an invaluable guide to many interesting branches of Iroquois ethnology. Many of the facts contained in this document are familiar to students, but that they formed a part of a definite system of law will perhaps be new. The Iroquois called this code the Gayeneshagowa, or the Immutable Law of the Great Peace. The term Great Peace refers to the Iroquois government.

Originally the Five Nations of Iroquois were similar to all other Indian tribes or bands — independent bodies with similar dialects and similar customs but with no political coherence. Each man and each tribe to itself, was the rule. Often the individual nations warred with one another, and with external enemies pressing them

from all quarters they found themselves in a precarious situation. The very peril in which they lived developed their strategic ability and fostered diplomacy. It likewise produced leaders and finally the great lawgiver who should bring about peace and unity and make the Iroquois the "Indians of Indians," the "Romans of the New World." Hale referred to Hiawatha as the "lawgiver of the Stone age"[1] but Hiawatha himself does not deserve the title.

The Mohawk nation recognizes in Dekanawideh its great culture hero and the founder of its civic system, giving Haiyentwatha (Hiawatha) a second place. Nearly all authorities among the other nations of the five agree in this and attribute to Dekanawideh the establishment of the Great Peace. The prefatory articles of the Great Immutable Law recognize him as such and represent him as saying:

I am Dekanawideh and with the Five Nations' Confederate Lords I plant the Tree of the Great Peace. I plant it in your territory, Adodarhoh and the Onondaga Nation, in the territory of you who are Fire Keepers.

I name the tree the Tree of the Great Long Leaves. Under the shade of this Tree of the Great Peace we spread the soft white feathery down of the globe thistle as seats for you, Adodarhoh and your cousin lords. . . . There shall you sit and watch the Council Fire of the Confederacy of the Five Nations. . . .

Roots have spread out from the Tree of the Great Peace . . . and the name of these roots is the Great White Roots of Peace. If any man of any nation outside of the Five Nations shall show a desire to obey the laws of the Great Peace . . . they may trace the roots to their source . . . and they shall be welcomed to take shelter beneath the Tree of the Long Leaves.

The Smoke of the Confederate Council Fire shall ever ascend and shall pierce the sky so that all nations may discover the central Council Fire of the Great Peace.

I, Dekanawideh, and the Confederate Lords now uproot the tallest pine tree and into the cavity thereby made we cast all weapons of war. Into the depths of the earth, down into the deep underearth currents of water flowing into unknown regions, we cast all weapons of strife. We bury them from sight forever and plant again the tree. Thus shall the Great Peace be established and hostilities shall no longer be known between the Five Nations but only peace to a united people.

As one gets further into the unique document the method by which universal peace is to be established is revealed. All nations were to sit beneath the Peace Tree and acknowledge the imperial regency

[1] Proc. Am. As. Adv. Sci., vol. 30, p. 324. 1881.

of the Five Nations' Council. To the Five Nations this seemed a very simple thing for they called themselves Ongweoweh, *Original Men,* a term that implied their racial superiority. Thus to them it seemed quite natural that other nations should acknowledge their right to rule. They never doubted the justness of their claim or saw that it possibly could be disputed. With them it was the basis for universal action. Other nations were inclined to dispute that the Iroquois were inherently superior and naturally rebelled at the idea of submission even though it might be for their own ultimate benefit.

From tribe to tribe, tradition shows,[1] the emissaries of the Great Peace went carrying with them the messages in their wampum strands, and inviting delegates to sit beneath the Peace Tree and "clasp their arms about it" and to discuss the advantages of an alliance.

The political success of the Iroquois as a result of their system gave them phenomenal strength and likewise excited widespread jealousy. Thus the Iroquois found themselves plunged in a war for existence and without friends to call upon.

How a government calling itself the Great Peace provided for war is shown in the part of the Great Immutable Law called "Skanawatih's Laws of Peace and War." Extracts from these laws follow:

When the proposition to establish the Great Peace is made to a foreign nation it shall be done in mutual council. The nation is to be persuaded by reason and urged to come into the Great Peace. If the Five Nations fail . . . after a third council . . . the War Captain of the Five Nations shall address the head chief of the rebellious nation and request him three times to accept the Great Peace. If refusal steadfastly follows the War Captain shall let a bunch of white lake shells fall from his outstretched hand and shall bound quickly forward and club the offending chief to death. War shall thereby be declared and the War Captain shall have his men at his back to support him in any emergency. War shall continue until won by the Five Nations. . . . Then shall the Five Nations seek to establish the Great Peace by a conquest of the rebellious nation.

When peace shall have been established by the termination of the war . . . then the War Captain shall cause all weapons of war to be taken from the nation. Then shall the Great Peace be established and the nation shall observe all the rules of the Great Peace for all time to come.

Whenever a foreign nation is conquered or has by their own free

[1] See for example The Passamaquoddy Wampum Records by J. D. Prince, page 483, Proc. Am. Philos. Soc., vol. 36.

will accepted the Great Peace their own system of internal government may continue so far as is consistent but they must cease all strife with other nations.

In this manner and under these provisions and others every rebellious tribe or nation, almost without exception, was either exterminated or absorbed. The Erie, the Neutral, the Huron, the Andaste and other cognate tribes of the Iroquoian stock were broken up and the scattered bands of survivors settled in the numerous Iroquois towns to forget in time their birth nation and to be known forever after only as Iroquois. The law read, "henceforth let no one so adopted mention the name of their birth nation. To do so will hasten the end of the Great Peace." The Lenni Lenape or Delaware, the Nanticoke, the broken bands of the Minsi and the Shawne, the Brotherton and other Algonquian tribes yielded to the armed persuasions to accept the Great Peace; likewise did the Tutelo and Catawba of the eastern Siouan stock and the Choctaw of the Muskoghean yield and to that action is due the fact that they have descendants today.

The Iroquois policy of adopting captives led to the mixture of widely scattered stocks. The Iroquois therefore became an ethnic group of composite elements. Thus from the ideas of universal peace and brotherhood grew universal intermarriage, modified of course by clan laws.

According to the Great Immutable Law the Iroquois Confederate Council was to consist of fifty Rodiyaner (civil chiefs) and was to be divided into three bodies, namely, the Older Brothers, the Mohawk and the Seneca; the Younger Brothers, the Cayuga and the Oneida, and the Fire Keepers, the Onondaga. Each brotherhood debated a question separately and reported to the Fire Keepers. In case of disagreement in opinion the Fire Keepers referred the matter back and ordered a unanimous report. If the two brotherhoods still disagreed the Fire Keepers had the casting vote. If, however, the brotherhoods agreed and their decision was not in accord with the wishes of the Fire Keepers the Fire Keepers could only confirm the decision for absolute unanimity was the law and required for the passage of any question. Provisions to speedily break any deadlock were provided. All the work of the council was done without an executive head, save a temporary speaker appointed by acclamation. Adodarhoh in spite of his high title was only the moderator of the Fire Keepers.

These "Lords" or civil chiefs were nominated by certain noble-

women in whose families the titles were hereditary and the nominations were confirmed by popular councils both of men and of women and finally by the Confederate Council. Women thus had great power for not only could they nominate their rulers but also depose them for incompetency in office. Here, then, we find the right of popular nomination, the right of recall and of woman suffrage, all flourishing in the old America of the Red Man and centuries before it became the clamor of the new America of the white invader. Who now shall call Indians and Iroquois savages!

Not only were there popular councils to check an over-ambitious government but both the men and the women had in their "War Chief" a sort of aboriginal public service commissioner who had authority to voice their will before the Council. Men of worth who had won their way into the hearts of the people were elected Pine Tree chiefs with voice but no vote in the governing body. The rights of every man were provided for and all things done for the promotion of the Great Peace.

Among the interesting things in this Iroquois constitution are the provisions for the official symbols. Many of these symbols, such as the point within a circle, the bundle of arrows, the watchful eagle, are described in detail. The fifteenth string in the Tree of the Long Leaves section, for example, reads:

"Five arrows shall be bound together very strongly and each arrow shall represent one nation. As the five arrows are strongly bound, this shall symbolize the union of the nations . . ."

This reference to the arrows bound together was quoted by King Hendrick in 1755 in his talk with Sir William Johnson.

Perhaps a more striking paragraph to students of Indian history will be the reference to a certain wampum belt:

"A broad, dark belt of wampum . . . having a white heart in the center on either side of which are two white squares all connected with the heart by white rows shall be the emblem of the unity of the Five Nations. The white heart in the middle . . . means the Onondaga nation . . . and it also means that the heart of the Five Nations is single in its loyalty to the Great Peace . . ."

This belt is sometimes called the Hiawatha belt and is one of the most valuable Iroquois belts now extant. It is now on exhibition in the Congressional Library.

The Great Peace as a governmental system was an almost ideal one for the stage of culture with which it was designed to cope. I

think it will be found to be the greatest ever devised by barbaric man on any continent. By adhering to it the Five Nations became the dominant native power east of the Mississippi and during colonial times exercised an immense influence in determining the fate of English civilization on the continent. They, as allies of the British, fought for it and destroyed all French hopes for colonization.

The authors of the Great Immutable Law gave the Iroquois two great culture heroes, heroes without equal in American Indian annals. Through the law as a guiding force and through the heroes as ideals the Iroquois have persisted as a people, preserved their national identity and much of their native culture and lore. Today in their various bodies they number more than 16,000 souls.[1] This is a remarkable fact when it is considered that they are entirely surrounded by a dominant culture whose encroachments are persistent and unrelenting in the very nature of things.

The Canadian Iroquois indeed govern themselves by the laws contained in these codes, proving their utility even in modern days.

Fate of the New York State collections in archeology and ethnology in the Capitol fire. In the New York State Capitol conflagration of March 29th the archeological and ethnological collections of the State Museum were almost totally destroyed by fire and water. The collections were installed in vertical wall and square alcove cases about the corridors at the head of the western staircase. The location seemed to insure singular protection from fire, there being nothing inflammable in the vicinity save the molding that held the cases together. The damage seems to have been done by the long sheets of flame that burst through from the large corridor windows of the library bindery on one side and of the Education Department offices on the other. The immense amount of inflammable material there fed the flames once established and the draft caused by the breaking of the heavy plate windows that opened out into the hall about the staircase carried the blast directly against the cases, shattering the glass and exposing the specimens within. The archeological cases suffered most from the breakage brought about by the crumbling of the sandstone ceilings that had been subjected to the intense heat. The falling of the ceilings in great blocks broke the shelves that had so far resisted the fire and spilled the specimens into the water and debris. The continual dropping of masses of cracked rocks from the walls made work of rescuing valuable objects most hazardous. However, despite the choking smoke, the sudden

[1] Southern Workman, Dec. 1911.

blasts of heat, and the falling walls the majority of the more valuable articles yet untouched by the fire were carried to safety.

The ethnological exhibits consisted principally of three large collections; one made by Lewis H. Morgan before 1854 and embracing some 200 objects, the Harriet Maxwell Converse collection of about 350 specimens, and the collection made by the present Archeologist, embracing nearly 200 rare objects, exclusive of silver ornaments. The famous Morgan collection of old Iroquois textiles and decorated fabrics went up in the first blast of flame, and the cases were burned to their bases. Fortunately about 50 Morgan specimens were in the office of the Archeologist for study purposes, and were thus preserved. The Converse collection of silver articles was rescued intact, though nearly a hundred other brooches and one large medal were lost. Many of the less inflammable objects were rescued during the fire and carried out of the danger zone. None of the wampum belts of the Six Nations was injured.

One of the odd features of the calamity was that hardly a single object connected with the ceremonies of the Iroquois totemic cults or the religious rites was injured. The hair of the thirty medicine masks that hung in a line across the westernmost cases was not even singed.

Of the 10,000 articles on exhibition, including about 3500 flints, only 512 have been identified by their catalog numbers. One thousand other articles, more or less impaired by the action of fire and water, will entail a great deal of work to identify.

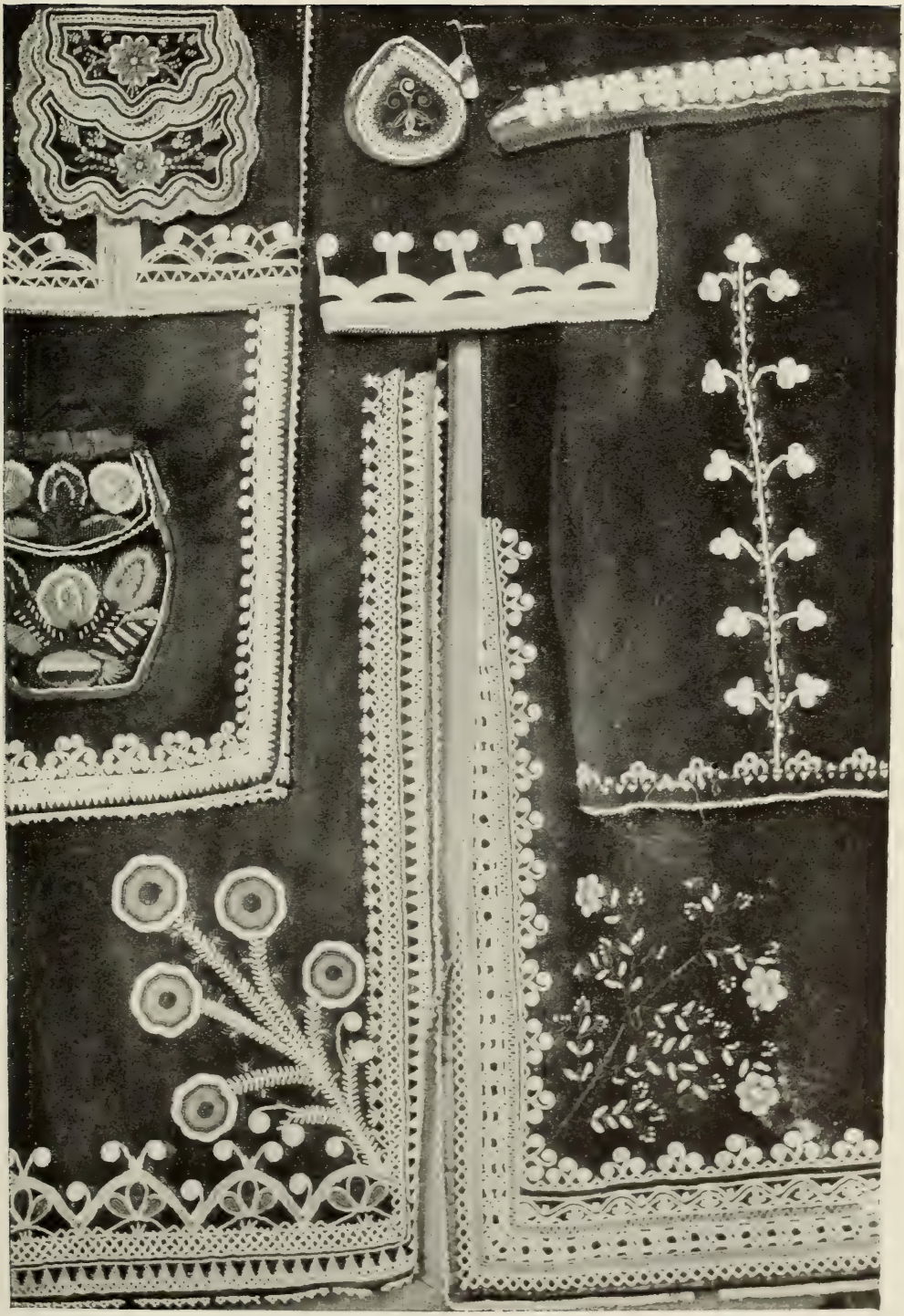
It is a curious fact that catalog numbers applied directly to the surface of the stone, bone or clay specimens with waterproof ink, withstood the action of fire and water better than the numbers painted on white varnish or on paper labels. Even when the object had been considerably heated the ink number on the surface was still legible. Paper labels proved valueless, especially those with typewritten numbers. Those with numbers written in waterproof ink came through better.[1]

A conflagration of the magnitude of the Capitol fire is not without its lesson. Its occurrence but adds weight to the oft repeated observation that no building is fireproof when it contains inflammable material. Such material, if in sufficient quantity, once burning, will ruin fire proofing material and expose new channels for the sweeping tongues of flame. The heat will crack walls, crumble stone

[1]American Anthropologist, January-March, 1911.

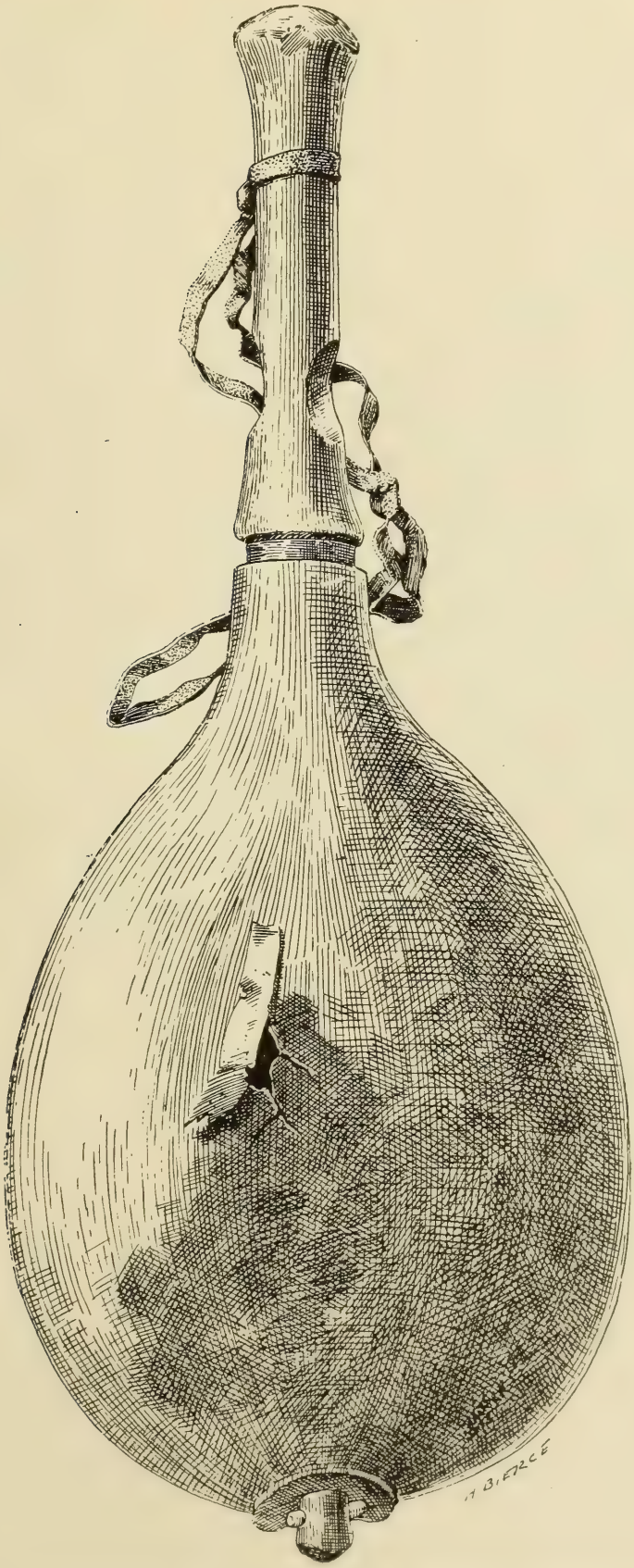
Buckskin side pocket decorated with porcupine quills. (Saved from the Capitol fire.) Morgan collection.

Neck pouch decorated with porcupine quills. Mohawk specimen from Morgan collection.



Iroquois beaded garments saved from the Capitol fire.
Mostly Morgan specimens.

The western side of the upper western staircase hall showing how the fire crumbled the stone ceiling and crushed the cases. Some of the wooden cases did not burn. Photo by Coulson and Wendt.



Seneca medicine rattle rescued from the Capitol fire of 1911. A hole was burned in the rattle without destroying the paper label. Converse collection

window sills and precipitate stone and plaster ceilings. Marble wainscotings will chip and fall, tile will loosen and soldered joints will melt.

The selection of the top hall about the western stairway seemed to insure absolute immunity from destruction by fire, but if one were disposed to ask why the Museum authorities of some fifteen years ago did not provide fireproof metal cases and thus doubly insure the valuable collections from damage by fire, a reasonable answer would be that the installation in glass cases with metal frames could in nowise have saved the specimens but only have helped to destroy them. Of the wooden framed cases, only those directly in contact with the root of the flame were burned to their bases. Those exposed to the indirect shafts of flame were not burned, and in some cases the varnish was not even blistered, though the heat was intense enough to melt the glass and expose the contents of the cases. In such of the cases as contained metal supports for shelves, the supports warped and fell and threw the specimens to the lowest level in the case. With the cracking of the plate glass the specimens were thrown in confusion. In the four-sided cases the heavy wooden framework of the case was in no instance burned though in all the glass was cracked by the heat.

A second destructive force was the falling of the heavy sandstone ceiling. Chunk by chunk the stone fell, the pieces varying from three or four cubic inches to great blocks of half a cubic yard. It was the falling of such masses of stone that crushed the cases not otherwise injured. The use of water in the hall to reduce the heat and extinguish the fire was almost as destructive in certain cases. The buckskin clothes in superheated cases were entirely ruined by the play of water upon the glass. The glass cracked and the water entering the cases shrunk the skin articles to one-fourth their size and left them crisp, shriveled objects when the heat had dried them again.

Public interest. Public interest in the work of this section has largely increased. This is due, first, to the natural interest created by a definitely organized archeological and ethnological bureau with a definite policy; and second, to the unusual activities resulting from the use of the funds provided by Mrs F. F. Thompson for carrying out the plan to create a series of ethnological groups. These groups, described elsewhere in this portion of the report, have attracted the attention of many persons interested in history and in anthropology.

Correspondence has grown as the result of the awakened interest

of the public. Inquiries come each day regarding Indian history and anthropology, sometimes many of them. The range of inquiry is broad and covers almost every Indian subject from the interpretation of Indian place-names to opinions as to the legal status of the Indian, from a modest request for a written account of the history of a tribe to a request to outline a scheme for an archeological survey of a country. Many replies to these letters partake of the nature of manuscripts rather than letters and indeed some of the "letters" have been reedited and without further addition to the text worked up into ten or twelve page magazine articles.

With this confidence of the public in our facilities to furnish information on the subjects dealt with by this section of the Museum, better facilities should be provided. Clerical assistance is an imperative necessity.

Another indication of public interest is expressed by the donation of collections and specimens to the Museum. This form of public interest is very gratifying.

Condition of collections. At the close of the fiscal year October 1, 1910–October 1, 1911, a new serial card catalog had been prepared. This work extended through several years, odd moments being employed. The collection number was supplemented with a museum serial number affording better means of identification.

In connection with this work the collections were rechecked from the old lists prepared by Mr A. G. Richmond in 1898. This was an arduous task and one requiring much patience but it resulted not only in improving the condition of the collections but gave the Archeologist a personal familiarity with nearly every specimen and an exact knowledge of the location of every important one. This knowledge became most useful during the fire and during the early hours of the Capitol fire facilitated the rescue of such important relics as were not already destroyed.

The only archeological collection now on exhibition in the Capitol is the collection secured by the Archeologist and his special assistant at Ripley in 1906. This material was exhibited just outside the fire zone and though it was endangered it was carried to a place of safety and not a specimen was injured.

The material now on hand consists of the following lots:

Fire salvage, identified specimens	541
Packed collections, miscellaneous	600
Ripley, Chautauqua co., collection	1050
Mattern collection	2300
Amidon collection	300

Various small collections and exchanges	1200
Expedition collections	1050
Ethnological material	320
Silver articles	159
	7520

Most of this material is in storage but is in good condition. The fire destroyed our best material at the precise point when we had begun to think we had a representative series of collections from the various parts of the State. We are therefore seriously crippled and our extensive plans for a systematic exhibition have received a setback. Nearly all the material acquired before the appointment of a permanent curator (in 1906) has been wiped out. That which has since been acquired by purchase and donation and through the personal work of the Archeologist in the field has been largely saved. It is a source of some satisfaction to know that his labors have not come to naught.

The Governor Myron H. Clark Iroquois exhibit. Much time has been given to the advancement of this work which involves the preparation of cultural groups of the Six Nations in life-size dimensions. In the course of the last two or three years the life casts necessary for the six groups planned have been gradually assembled and of the large backgrounds measuring 50 by 20 feet which are required for the scenic effect, three have been painted and others are in progress. The greatest care has been taken in the selection of the types of figures from an ethnological point of view. It is not always or often easy to distinguish members of the Six Nations from one another and therefore it has been almost compulsory to take the men, women and children from the reservations regardless of their tribal relations, provided they preserved well their racial physiognomy. The six proposed groups call for about forty figures and of these nearly all have now been made. The making of these life casts is a matter of some delicacy and difficulty inasmuch as the subject must assume and hold just that pose which the figure is to have in the resultant group.

Toward the close of the summer, in view of the accumulated material, it seemed well to attempt the assembling of the first of these groups. The bringing together of the essentials for them had had its difficulties but the crucial test of the success of the undertaking lay in the final assembling and construction of a group with all its belongings in place. This therefore was undertaken and a temporary case erected in the Universalist church which serves as an

The Iroquois exhibit: HUNTER GROUP OF SENECA INDIANS. Scene, Canandaigua Lake; figures, life size

archeological laboratory, wherein the Seneca Hunter group has been thus brought together and carried through to a completion of all its details. In the assembling of this group we had the benefit of an experience which will be of essential service in the construction of the remaining groups and it has required a large amount of time, labor and patience, as well as artistic ingenuity to produce the effect desired, particularly in making the foreground of the group disappear without break or obtrusive interval into the background of the picture. The work in its conclusion appears to be in all regards a success, both artistically and as an almost living expression of this particular phase of Indian activity. This group has not been exposed to public view but has been privately shown to a number of appreciative and intelligent people competent to see any of its shortcomings and appreciate its merits, and it is gratifying to feel that the work has met with quite unqualified approbation.

This Seneca Hunter group represents a camp site on the west side of Canandaigua lake looking across the lake toward the hill Genundewa, or Sacred Hill of the Senecas. The time is the early dawn of a spring day. Looking out from the pine woods which is the location of the camp, the eye catches the shimmer of the dawn upon the waters of the lake and the glow of the coming sun upon the almost cloudless sky beyond the distant hills. The group of figures in the foreground consists of five, the father coming in from an early morning hunt with a fawn on his back, the mother at the skiving log cleaning a deer skin, the daughter on her knees cutting venison into strips, a lad felling a tree in the aboriginal mode of burning the trunk and chopping out the charred matter, and the elder brother, a warrior in full warrior's garb and headtrim. The costumes have been specially designed and adapted to show the clothing of the time, which is supposed to antedate the coming of the white man. The life casts employed are the handiwork of a very skilful sculptor, Mr Caspar Mayer, and have been drawn with such attention to posture and to detail as to retain the surface of the skin in admirable and lifelike perfection.

The completion of this group has satisfactorily demonstrated the possibility of bringing all the groups to a similar successful issue but it has for the present obstructed and impeded the working quarters of the Museum so that the auditorium of the church which has been used some time past as the study of the artist, Mr David C. Lithgow, who has painted the backgrounds, is diminished to about one-half its size and the continuation of the artist's work will be

prosecuted at some disadvantage. It is hoped to complete the cases for these groups in the Education Building early and by so doing enable the removal of the first group to its proper place and with it out of the way opportunity will be afforded to try out the other groups experimentally before setting them up in their final resting places.

I should take this occasion to speak here with very great appreciation of the admirable service rendered by David C. Lithgow, the artist of the background pictures, in the matter of assembling the parts of this group and bringing out the difficult distance effects so essential to the perfection of the assemblage. The work has required not only artistic appreciation but a large degree of mechanical ingenuity and execution.

Not all of the work of the year has been given to the matter of perfecting this group. During the winter months and up into the early spring Mrs Shongo and her daughter, Mrs Maud Shongo Hurd, two Seneca women, were employed in the Archeologist's rooms in embroidering deerskin costumes in quill, moose hair and beadwork for these life casts. The art of working in moose hair and quill is almost extinct and so indeed is that of working all embroidery of the old style. These women were the only ones found who were still familiar with the technic of this handiwork. Great care was taken in the execution of this work to have every design and detail authentic.

The Archeologist in the early summer located the historical sites for subjects of backgrounds; an Oneida village near Nichols pond in the town of Fenner, Madison county, an Oneida stronghold stormed by Champlain in 1615, and the Onondaga capital village in the town of Manlius, Onondaga county. The latter is now known as Indian Hill and overlooks the valley of Limestone creek. Some weeks were consumed here by Mr Lithgow in making the sketches that are to serve as the data for his large paintings. Later in the summer a site was selected for the Cayuga Ceremonial group at Utt's Point.

The selection of additional models from among the Onondagas who were to pose for the various characters in the Onondaga Council group was a matter of some difficulty and when the models were secured they were brought to Albany and very successfully cast by Henri Marchand, and in some cases casts of typical faces have been made by the Archeologist himself.

Materials for the accessories to the groups have been sought for

A life cast of an Onondaga chief made for the Council group of the Hall of Iroquois Ethnology, by Sculptor Henri Marchand.

A corner in the plaster studio. Life casts of two Indian women, a baby and a man are being painted by Sculptor Mayer, for the Hall of Iroquois Ethnology.

Typical Iroquois moose hair decoration on buckskin. From leggings made 1910–11 by Mrs A. Shongo and Mrs M. Shongo-Hurd, Seneca women.

and found, among other things a suitable log cabin for the Cayuga group which was obtained on the Tonawanda reservation and has been shipped to Albany. Every log in this cabin was so numbered that its reconstruction is made easily possible.

At the present time the work of painting the background for the Oneida group is proceeding as rapidly as practicable and it may be said that the materials necessary for all the groups are essentially ready to assemble.

LIST OF ARCHEOLOGICAL SPECIMENS DESTROYED IN THE CAPITOL FIRE, MARCH 29, 1911

Pair of silver bracelets
6 pairs of silver earrings
Silver hatband
Silver bracelets
Belt
Wampum beads
Ladle
Wooden mask
2 bows
Ball bat
Baby frame
Gambling bowl
Dice (of peach stones) for gambling bowl
Seneca corn soup paddle
Indian flute
Iroquois sacred flute
Provision bag — seamless
Corn husk mask
Corn husk dishes (2), Seneca
Corn husk water bottle
Corn husk salt bottle
2 basket meal sifters
Bark sap tub
Bark tray
Box, birch, and moose hair work
2 Indian dolls
Carved stone pipe
Indian sling for hurling stones
Pair of women's beaded cloth leggings
2 pairs women's moccasins
Very old work pouch
Pair Indian buckskin mittens
Mary Jemison's soup ladle
Seneca bark ladle
Very ancient bone spoon
Amulet stone (Seneca)
Kettle
Model of wooden corn mortar and pestle
Ring puzzle
Indian drum
Card containing catlinite ornaments, copper bells and Venetian beads
Shell ornament
13 ceremonial stones
Long canoe-shaped slate stone
Stone ornament
Bird or eagle stone
Slate ball
Bar amulet
Sinew stone
15 clay pipes
7 stone pipes
5 stone gouges
Turtle shell
Bone comb
2 deer antlers
Bone harpoon
3 bone awls
Bone needle
Bone object
Bone mask of human face
Bone carving
15 bone (bird) beads
2 bone fish-hooks
String with various kinds of beads
7 catlinites
1007 beads
8 stone sinkers
Stone gouge

6 stone pestles
Decorated pottery
3 hammer stones
48 spear heads
6 scrapers
7 chert knives
10 leaf-shaped objects of chert
Chert flake with saw edge
4 chert drills
215 shell beads
Game stone
Flint agricultural tool
Stone for smoothing and rounding arrow shafts
Slate ornament
Discoidal or Chunkee stone
3 clay vessels
Red paint
16 stone celts
Stone chisel
Card containing:
- 4 copper arrow points
- 2 iron knife blades
- 1 iron chisel
- 3 copper arrow points
- 1 iron fish-hook
- 1 copper bead
- 1 iron awl
- 5 copper thimbles
- 2 copper bells
- 1 copper bracelet
- 10 copper tubes
- 1 copper disk
- 1 copper ring
- 1 piece graphite

116 arrow points
Chert agricultural implement
Card containing 11 arrow points
Small stone object in form of bean
Deer's antler cut to a beveled edge on end
2 perforated canine teeth
3 stone axes
Stone maul
Stone mortars (2)
Card containing 124 arrow points drills, spear heads, knives and leaf-shaped objects
21 chert gambling pieces
Shell ornaments
4 shell beads
35 bones, taken from feet of wolves, finished for necklace use
2 bones for smoothing purposes
5 bones used in manufacture of arrows
8 bears' teeth used for different purposes
14 bones used for rubbing or smoothing purposes
15 bird bones cut for use as beads
3 bone harpoons for fishing
Bone fish-hook
56 bone objects for different purposes
10 deer horn objects for different purposes
21 bone arrow points
106 bone awls
Human skull with perforations
Esquimaux object made of ivory
44 clay pipes
33 stone pipes
2 bayonets
2 buttons
Part of flint lock gun
29 fragments of decorated pottery
Copper disc
3 clay discs
2 stone objects
2 bird stones
12 stone gouges
Soapstone kettle
Iron tomahawk
String of Indian beads and ornaments
Green serpentine stone axe
11 stones used for sharpening purposes
5 rubbing stones
4 fragments soapstone kettles
Stone fishing sinkers
Grooved stone axe
2 western arrow points
8 stone corn pounders or pestles
8 game stones
5 hammer stones
Ceremonial stones (13)
2 stone tubes
2 stone knives
Copper spear head

4 clay vessels
3 chert drills
51 arrow points
9 chert leaf-shaped implements
3 scrapers
50 spear heads
5 heads of various animals in clay
24 clay pipe bowls
3 clay pipe fragments
2 stone axes
66 stone celts
Stone mortar
Indian war club
Iron tomahawk and pipe combined
23 clay vessels
3 copper kettles
2 carved bone images of human beings
7 bone tools
3 bone arrow points
Stone celt
3 stones for sharpening tools
Stone sinker
5 stone spear heads
8687 Venetian glass beads
3 stone pipes
23 clay pipes
10 portions of turtle shell
6 portions of wooden ladles
3 cloth fragments
Strip of buckskin clasped with copper fasteners
Necklace
Copper tube
String of 140 wampum beads 20 inches long
String of 378 wampum beads 54 inches long
String of 392 wampum beads 56 inches long
String of 700 wampum beads 56 inches long
4 strings of beads
Necklace composed of the teeth of the bear and wolf (62 in number)
String of 23 teeth of the elk
String of 11 natural shells
String of 256 copper beads
2 grinding stones
8 iron trade axes
Copper kettle containing 109 arrow points
2 chert knives
Leaf-shaped implements (2)
Stone pipe
3 clay pipes
Bone comb
Necklace (very fine specimen)
3 necklaces consisting of shell ornaments
147 miscellaneous ornaments
Wooden spoon
Wooden cup
Bone spoon
Clay vessel
Pair of copper bracelets
8 strings of beads (various kinds)
Brass kettle containing 68 various objects
15 cards containg 111 Indian relics of various kinds
Land tortoise shell with perforations
29 gambling devices
Bone punch
Bone handle
3 chert scrapers
5 leaf-shaped objects
2 spear heads
12 arrow points
2 chert drills
Ceremonial stone
5 stone celts
Grooved axe
2 gouges
8 sharpening stones
4 stone corn pounders
7 game stones
2 iron axes
Iron hoe
Fragments of pottery
8 strings of beads of various kinds
6 clay pipes
58 clay pipe fragments
Lead pipe
Copper pipe
2 stone pipes
2 stone pipe fragments
Bone comb
2 clay vessels
Clay disk

13 clay pottery fragments
72 bone tools (fragments)
3 soapstones (decorated)
7 soapstones (plain)
4 ceremonial stones
79 stone knives
Iron trade axe
3 chert drills
5 game flints
Long gun barrel
Jasper scrapers (7)
5 quartz scrapers
11 copper beads
2 copper arrow points
Piece of decorated copper
22 celts
4 stone mullers
3 stone hammers
2 sharpening stones
3 sinew stones
Chert spade
11 stone plummets
4 stones used for agricultural purposes
28 stones used for various purposes
25 leaf-shaped implements
392 spear heads and arrow points
126 chert drills
23 large chert objects
Rubbing stone
615 chert scrapers
Copper ring
Brass kettles
91 flint points
Shell gouge
Shell chisel
2 pipes (red stone)
Tomahawk
Shell ornaments
10 bone implements
3 bone ornaments
Totem pipe
2 pipes
Fish hook of bone
3 sink stones
Wampum beads
2 ceremonial stones
2 celts
Pottery fragments
Fish hook and line

Clay pipes (4)
Steatite pipe
Stone pipe
Bird stone
Copper spear head
10 spear heads
Ceremonial object
Indian skull
Tomahawk
2 stone chisels
17 stone knives
Scraper
6 gouges
3 sinkers
11 celts
11 grooved axes
2 stone hammers
8 drills or perforations
19 spear heads or knives
26 arrow points
6 pestles
2 ceremonial objects
Steatite pipe
3 celts
Hammer and sinker combined
Game stone
Knives or spears (12)
55 spear heads
132 arrow points
5 bunt scrapers
Copper spear head
6 stone pestles
8 celts
Hammer stone
Grooved axe
Stone mortar
Leaf-shaped chert implements (7)
4 drills
Iron trade-axe
38 hammer stones
19 celts
13 scrapers
70 clay pipe fragments
3 clay disks
8 stone disks
11 beads
8 bone awls
3 bone needles
98 bone tools
Bone pottery marker

Human faces molded in clay (2)
8 shell ornaments
296 bones and teeth for ornamental and useful purposes
235 pottery sherds (decorated)
13 pottery sherds (plain)
2 stone ornaments
2 mortars
Sharpening stone
2 iron axes
1 stone pipe
16 beads
10 arrow points
Game stone
31 arrow points
8 gun flints
Copper ornament
48 arrow points
Red slate pendant
Decorated clay pottery fragments (35)
7 plain clay pottery fragments
2 celts (fragments)
9 clay pipes (fragments)
5 celts
3 hammer stones
Animals' bones and teeth (27)
Sandstone pipe
3 bone awls
Bone arrow
2 game stones
4 shells
Pottery vessel
5 bone tools
Scraper
5 spear heads (chert)
Spear head (copper)
31 arrow points
13 arrow points (copper)
Arrow point (bone)
2 knives
2 drills
6 gun flints
Sinker
4 leaf-shaped pieces of chert for various purposes
2 iron knives
Smoothing stones
81 pottery sherds (decorated)
68 pottery sherds (plain)
Pottery marker
133 animal bones
25 shells
3 bone tools
Harpoon (bone)
Flaking tool
Corn pounder
Rubbing stone
4 scrapers
5 pottery pipes (fragments)
Copper kettle (fragment)
2 bone awls
Hammer stone
3 stone mortars
2 stone pestles
12 stone chisels
Stone gouge
Spear head (chert)
Indian knife (chert)
4 tomahawks
Brass kettle
Gun lock and rifle barrel
2 war clubs
Moccasin needle
Stone tube
Stone amulet
Indian necklace of teeth
Earthen basin
Headdress (Seneca)
Calumet
Leaden cross
Stone skull cracker
La Crosse sticks (2)
2 Indian bows
6 feathered arrows
2 snow snakes
Bark tray or platter
2 splint baskets
Medicine pouch
String of stone beads
Bark canoe (model)
4 paddles
Cigar case
2 card receivers
Watch case
2 clay pipes
3 pipes (not complete)
16 arrow heads
Arrow head (copper)
Knee rattle

Arm bands (1 pair)
Wrist bands (1 pair)
Knee bands (1 pair)
Indian belts (3 varieties)
Moccasins (2 pairs)
2 kilts or skirts
2 pairs leggings
Necklace
Pin cushions (3 varieties)
Work bags (5 varieties)
Pocketbooks (6 varieties)
Breech cloth
Needle book
Baby frame
3 bark trays
2 hominy blades
Bowl for game, with peachstones
Deer buttons for an Indian game
Javelins for an Indian game
4 tobacco pouches
Ball bat for an Indian game
Pipe
6 Indian bows
2 burthen-straps
2 skeins
2 husk salt-bottles
Air gun
Bow and wheel for striking fire
2 basket sieves
Open-work basket
Toilet basket
Headdress
Sheaf for carrying arrows
Satchel
Work bag
2 pin cushions
Kilt
Deerskin shoulder-belt
3 moccasins
Shot pouch
3 hominy blades
Bread turner
4 wooden ladles
Wooden spoon
6 bark trays
Bark sap-tub
Glass beads
2 canes
Belt and knife
Horn rattle
War club
2 Indian flutes
Indian bow
Ball bat
Feathered arrows (18 specimens in sheath)
Tobacco pouch
Moosehair and bark burthen-strap
Burthen-straps (6)
Grass shoulder ornament
2 bark ropes
Finger-catcher
Basket sieve
Covered basket
Hominy blade
Skirt
Leggings (2 pairs)
Broadcloth blanket
Snow-boat
Bark canoe
Museum collection of flints
Museum collection of pottery
Museum collection of polished stone articles

VII

PUBLICATIONS

A list of the scientific publications issued during the year 1910–11, with those now in press and treatises ready for printing, is attached hereto. The publications issued cover the whole range of our scientific activities. They embrace 1042 pages of text, 151 plates and 5 maps.

The labor of preparing this matter, verifying, editing and correcting is onerous and exacting. Taken altogether, it excellently indicates the activity and diligence of the staff of this division.

ANNUAL REPORT

1 Seventh Report of the Director, State Geologist and Paleontologist for the fiscal year ending September 30, 1910. 280p. 42pl.

Contents:

Introduction
I Condition of the scientific collections
II Report on the geological survey
Areal geology
Surficial geology
Industrial geology
Seismological station
Mineralogy
Paleontology
III Report of the State Botanist
IV Report of the State Entomologist
V Report on the zoology section
VI Report on the archeology section
Ethnology
Archeology
The Mary Jemison monument
VII Publications
VIII Staff
IX Accessions
X The New York State Museum Association
Comparative Sketch of the Precambric Geology of Sweden and New York. J. F. KEMP
Notes on the Geology of the Swedish Magnetites. D. H. NEWLAND
Notes on the Geology of the Gulf of St Lawrence. J. M. CLARKE
The Carbonic Fauna of the Magdalen Islands. J. W. BEEDE
Exfoliation Domes in Warren County, New York. W. J. MILLER
Studies on Some Pelmatozoa of the Chazy Epoch. G. H. HUDSON
Index

BULLETINS

Geology

2 No. 146 Geologic Features and Problems of the New York City (Catskill) Aqueduct. By Charles P. Berkey. 286p. 38pl. maps.

Contents:

Introduction and acknowledgment
I General features
Ch. 1 Catskill water supply project
2 Problems encountered in the project
3 Relative values of different sources of information and stages of development
4 General geology of the region
II Geologic problems of the aqueduct
Introduction
Ch. 1 General position of aqueduct line
2 Hudson river canyon
3 Geological conditions affecting the Hudson river crossing
4 Geological features involved in selection of site for the Ashokan dam
5 Character and quality of the bluestone for structural purposes

Ch. 6 The Rondout valley section
7 The Wallkill valley section
8 Ancient Moodna valley
9 Rock condition of Foundry brook
10 Geology of Sprout brook
11 Structure of Peekskill creek valley
12 Croton lake crossing
13 Geology of the Kensico dam site
14 Stone of the Kensico quarries
15 The Bryn Mawr siphon
16 A study of shaft 13 and vicinity on the New Croton aqueduct
17 Geological conditions affecting the location of delivery conduits in New York city
18 Areal and structural geology south of 59th street
19 Special exploration zones
20 The general question of postglacial faulting
Index

3 No. 148 Geology of the Poughkeepsie Quadrangle. By C. E. Gordon. 122p. 26pl. 1 map.

Contents:

Introduction
Location and other general features of the quadrangle
Topography
Drainage
General geology
Previous geologic work
Stratigraphical table
The Precambric gneisses
The Hortontown basic eruptive and associated metomorphic rocks
The basal quartzite (Poughquag)
The Wappinger (Barnegate) limestone
The Wappinger creek belt
The Fishkill limestone
The "Hudson River" slate group
Preglacial history of the drainage
Glacial geology
Retreat of the ice sheet
Postglacial erosion
The present depression
Other drainage features and adjustments
Land forms
Economic geology
Bibliography
Index

4 No. 151 The Mining and Quarry Industry of New York. By D. H. Newland. 82p.

Contents:

Introduction
Mineral production of New York
Cement
Clay
Production of clay materials
Manufacture of building brick
Other clay materials
Pottery
Crude clay
Emery
Feldspar
Garnet
Graphite
Gypsum
Iron ore
Millstones
Mineral waters

Natural gas
Petroleum
Pyrite
Salt
Sand and gravel
Slate
Stone
Production of stone
Stone (*continued*)
Granite
Limestone
Marble
Sandstone
Trap
Talc
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5 No. 152 Geology of the Honeoye-Wayland Quadrangles. By D. D. Luther. 30p. 1 map.

Contents:

Formations in ascending order
Ontaric or Siluric
Camillus shale
Bertie (and Cobleskill ?) waterlime
Devonic
Oriskany sandstone
Onondaga limestone
Marcellus black shale
Stafford limestone
Cardiff shale
Skaneateles shale
Ludlowville shale
Tichenor limestone
Moscow shale
Pyrite layer in horizon of Tully limestone
Devonic (*continued*)
Genesee black shale
Genundewa limestone
West River dark shale
Middlesex black shale
Cashaqua shale
Rhinestreet black shale
Hatch shale and flags
Grimes sandstone
Gardeau flags and shales
Nunda sandstone
Wiscoy beds
Chemung sandstone and shale
Dip
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Entomology

6 No. 147 Report of the State Entomologist for the fiscal year ending September 30, 1910. 182p. 35pl.

Contents:

Introduction
Injurious insects
Codling moth
Juniper webworm
Large aphid spruce gall
Ash psylla
Notes for the year
Fruit insects
Garden and grain insects
Shade tree pests
Notes for the year (*continued*)
Forest tree insects
Miscellaneous
Publications of the Entomologist
Additions to collections
Appendix
Miastor americana Felt, an account of pedogenesis
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Botany

7 No. 150 Report of the State Botanist for the fiscal year ending September 30, 1910. 100p. 10 pl.

Contents:

Introduction
Plants added to the herbarium
Contributors and their contributions
Species not before reported
Remarks and observations
New species and varieties of extralimital fungi
Edible fungi
Cranberry and Averyville marshes
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New York species of Psathyra
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8 Poughkeepsie quadrangle
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MEMOIRS

10 Birds of New York, volume 2
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BULLETINS

Geology

12 Glacial Geology of the Schenectady Quadrangle
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14 Glacial Waters in the Black and Mohawk Valleys
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STAFF OF THE SCIENCE DIVISION AND STATE MUSEUM

The members of the staff, permanent and temporary, of this division as at present constituted are:

ADMINISTRATION

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Jacob Van Deloo, Director's clerk
Paul E. Reynolds, Stenographer

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John M. Clarke, State Geologist and Paleontologist
David H. Newland, Assistant State Geologist
Rudolf Ruedemann, Assistant State Paleontologist
C. A. Hartnagel, Assistant in geology
Robert W. Jones, Assistant in economic geology
D. Dana Luther, Field Geologist
Herbert P. Whitlock, Mineralogist
George S. Barkentin, Draftsman
H. C. Wardell, Preparator
Michael T. Sammon, Stenographer
Martin Sheehy, Machinist
Joseph Bylancik, Page

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Prof. J. F. Kemp, Columbia University
Dr C. P. Berkey, Columbia University
Dr Arthur Hollick, Bronx Garden
G. H. Hudson, Plattsburg State Normal School
Prof. W. J. Miller, Hamilton College
Dr W. O. Crosby, Massachusetts Institute of Technology
Dr H. B. Kümmel, Trenton, N. J.
Burton W. Clark, Washington, D. C.

Geographic geology

Prof. Herman L. Fairchild, Rochester University
Prof. Albert P. Brigham, Colgate University

Paleontology

Edwin Kirk, Washington, D. C.

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Stewart H. Burnham, Assistant

ENTOMOLOGY

Ephraim P. Felt, State Entomologist
D. B. Young, Assistant State Entomologist
Fanny T. Hartman, Assistant
Anna M. Tolhurst, Stenographer
J. Shafer Bartlett, Clerk

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Arthur Paladin, Taxidermist

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Dr H. A. Pilsbry, Philadelphia

ARCHEOLOGY

Arthur C. Parker, Archeologist

Temporary assistant

E. R. Burmaster, Irving

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ACCESSIONS

ECONOMIC GEOLOGY

Collection

Newland, D. H. Albany
Building stones, rough and polished, from Adirondacks..... 20
Talc from St Lawrence county..... 5
Pyrite ore from Gouverneur, N. Y..... 2
Feldspar from New York quarries..... 12
Jones, R. W. Albany
Building stones, rough and polished, from southeastern New York. 40
Kaolin from Shenandoah, N. Y..... 5

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PALEONTOLOGY

Donation

Allardyce, Mrs W. L. Falkland Islands
Fossils from Falkland Islands..... 90
Cole, Rev. Thomas. Saugerties, N. Y.
Number of starfish on large slab..... 1
Foerste, Dr A. F. Dayton, Ohio
Clitambonites diversus-rogersensis Foerste..... 11

Hudson, Prof. G. H. Plattsburg, N. Y.
Asaphus marginalis from Valcour Island..... 2
Jones, R. W. Albany
Dictyonema crassum Girty. Cotype..... 1
Kirk, Edwin. Washington, D. C.
Fossils from Black River limestone, Kirkfield, Ontario, Canada.... 100
Ormiston, Prof. William T. Constantinople, Turkey
Devonic fossils from Roumeli-Hissar, Turkey..... 115

Exchange

van Ingen, Prof. Gilbert. Princeton, N. J.
Eurypterids from base of Salina at Farmers Mills, Oneida co., N. Y..... 8

Purchase

Dean, R. C. Dalhousie, N. B.
Devonic fishes from Migouasha..... 10
Krantz, Dr F. Bonn, Germany
Foreign trilobites..... 7
Plourde, Anthony. Migouasha West, P. Q.
Devonic fishes from Migouasha, P. Q., Canada..... 137

Collection

Clarke, John M.
Devonic fossils from near New Richmond, P. Q..... 6
Siluric fossils from New Richmond, P. Q..... 40
Lower Devonic limestones..... 10
Pleistocene shells from elevated beaches, New Richmond, P. Q., Canada 50
Mya truncata
Macoma sabulosa
M. balthica
Serripes groenlandicus
Chrysodomus despectus
Devonic coal, Cape Haldimand, Gaspé Bay, P. Q., Canada..... 1
Hartnagel, C. A.
Eurypterids from Herkimer county..... 570
Ruedemann, R.
Graptolites and eurypterids from Normanskill shale at Catskill.... 250
Fossils from lower Siluric shales and limestones of Schuylerville sheet 200
Wardell, H. C.
Fossils from Canajoharie (Trenton) shale near Watervliet..... 70
Starfishes from Hamilton formation in Ulster co..... 200

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MINERALOGY

Donation

Jones, R. W. Albany
- Native copper and cuprite, Box Elder co., Utah 1
- Pyrite (crystal) " " 1
- Malachite and azurite " " 1
- Cuprite and chysocolla " " 1
- Aurichalcite on azurite " " 1
- Malachite and chrysocolla " " 1
- Pyrite, Boulder co., Col 1

Sanford, Gen. Denver, Col.
- Pyrargyrite, Gunniston co., Col 1
- Sylvanite and fluorite, Cripple Creek, Col 1
- Sylvanite, Cripple Creek, Col 2
- Quartz (amethyst), Colorado 1

Hough, R. B. Lowville, N. Y.
- Sphalerite in quartz, Lyonsdale, Lewis co 1
- Quartz, Lyonsdale, Lewis co 5

Hartnagel, C. A. Albany, N. Y.
- Calcite, near Three Forks, Mont 4

Stow, J. E. Saratoga, N. Y.
- Marcasite and sphalerite, Elizabethtown, N. Y 1
- Malachite in limonite, Indian Lake, N. Y 1
- Tourmalin in pegmatite, Greenfield, N. Y 1
- Quartz in limestone, Saratoga, N. Y 1
- Malachite, azurite, chalcocite, Adirondacks (?) 5

Van Loon, E. S. Albany, N. Y.
- Aragonite in conglomerate, Albany, N. Y 3

Gavit, J. Albany, N. Y.
- Quartz (crystal), Wemple, N. Y 1

Herrick, D. W. Albany, N. Y.
- Quartz, New Baltimore, N. Y 1

Exchange

Law, E. S. Schenectady, N. Y.
- Quartz (crystals), Amsterdam, N. Y 15

Goodwin, H. R. Philadelphia, Pa.
- Barite on dolomite, Frizington, England 1

Jandorf, M. L. York, Pa.
- Cerargyrite, embolite and iodyrite, Tonopah, Nevada 1
- Pyrite in shale, York, Pa 5
- Chrysocolla and chalcocite, York, Pa 5
- Magnetite, Barts, Berks co., Pa 3
- Rutilated quartz, York, Pa 4

Purchase

Law, E. S. Schenectady, N. Y.
- Quartz on chalcedony, Amsterdam, N. Y 4
- Quartz (crystals), Amsterdam, N. Y 3

Collection

Assistant State Geologist and R. W. Jones

Titanite and fluorite, Fine, N. Y..... 5

Mineralogist and C. A. Hartnagel

Beryl (large crystals), Batchellerville, N. Y..... 10
Beryl (crystals), Batchellerville, N. Y..... 5
Beryl, in microcline and quartz, Batchellerville, N. Y..... 11
Muscovite (cleavage sheets showing inclusions), Batchellerville, N. Y..... 3
Muscovite (large crystals), Batchellerville, N. Y..... 8
Muscovite, in microline and quartz, Batchellerville, N. Y..... 8
Quartz (rose), Batchellerville, N. Y..... 7
Pyroxene and muscovite in pegmatite, Batchellerville, N. Y..... 1
Fluorite and quartz, Batchellerville, N. Y..... 1
Microcline (crystal), Batchellerville, N. Y..... 1

Mineralogist

Aragonite in conglomerate, Albany, N. Y..... 14
Quartz (chalcedony), Saratoga, N. Y..... 6
Quartz (flint), Saratoga, N. Y..... 3
Garnet and graphite in serpentine, Saratoga, N. Y..... 4

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ENTOMOLOGY

Donation

Hymenoptera

Miller, Mrs M. S. Boonville. Thalessa atrata Fabr., black long sting, July 6

Baker, A. N. Bellport. Rhodites bicolor Harr., spiny rose gall, old galls on rose, June 19

Douglass, J. A. Oriskany Falls. Cynips? prinoides Beutm., gall, September 14

Wallace, Sterling. New York City. Tremex columba Linn., pigeon Tremex, adults on hickory, September 12

Sharpe, H. C. Schenectady. Caliroa cerasi Linn., cherry and pear slug, eggs on cherry, June 3

Livingston, J. H. Tivoli. Kaliofenusa ulmi Sund., elm leaf miner, larvae on elm, May 30

Howe, Madam. Kenwood. Same as preceding, May 31

Graff, Stephen. Johnstown. Same as preceding, June 16

Helme, F. C. Chester. Trichiocampus viminalis Fallen, poplar sawfly, larvae on poplar, August 13

Harris, W. H. Greenfield Center. Same as preceding, August 30

Barron, Leonard. Garden City. Abia inflata Nort., larvae on Lonicera, June 8

State Department of Agriculture. Trichiosoma tibialis Steph., cocoon and pupa on Crataegus from Holland, April 10

Coleoptera

Hyle, Fisher. Germantown. Eccoptogaster rugulosus Ratz., adult, August 8

Cushman, R. L. Yonkers. E. quadrispinosus Say, adult on hickory, August 13

Brisbin, C. E. Schuylerville. Gymnetron teter Fabr., adult, June 21

Sargent, Miss G. W. Lenox, Mass. Rhynchites bicolor Fabr., rose curculio, adults and work, October 26

Nards, R. S. Slingerlands. Pomphopoea sayi Lec., Say's blister beetle, adults, May 31

Bowen, Smith. Hartford. Same as preceding, May 31

Hart, Matthew. Castleton. Same as preceding, on locust blossoms, June 5

Winne, C. M. Castleton. Same as preceding, adult, June 8

DeGarmo, A. C. Schuylerville. Same as preceding, June 8

Jansen, Frank. Fonda. Same as preceding, June 14

Ward, J. G. Cambridge. Same as preceding, June 16

Ward, Arthur. Philmont. Same as preceding, on cherry, June 20

Brisbin, C. E. Schuylerville. Same as preceding, adult, June 21

Fairman, C. E. Lyndonville. Meloe angusticollis Say, oil beetle, adult, September 15

Bush, Miss E. Albany. Tribolium confusum Duv., confused flour beetle, adults, November 29

Frost & Bartlett Co. Stamford, Conn. Chalepus dorsalis Thunb., locust leaf miner, adults on locust, August 30. Also C. nervosa Panz., adult on locust, August 30

Rose, J. F. South Byron. Systena taeniata Say var. blanda Melsh., adult on bean, June 29

Wicks, F. B. Ticonderoga. Galerucella luteola Müll., elm leaf beetle, larvae, June 28

Satterlee, H. L. Highland Falls. Same as preceding, larvae, pupae and adults on elm, July 6

Bell, Miss S. L. Amsterdam. Same as preceding, eggs on elm, July 21

Wood, Miss F. A. Poughkeepsie. Same as preceding, adult on elm, August 7

Bloodgood Nurseries. Flushing. Through State Department of Agriculture. Melasoma scripta Fabr., lined cottonwood beetle, egg, larvae and adult on poplar, August 18

Hicks, J. J. Jericho. Crioceris asparagi Linn., asparagus beetle, adults on asparagus, May 19. Also C. duodecimpunctata Linn., 12-spotted asparagus beetle, adults on asparagus, May 19

Shutts, W. H. Claverack. Saperda candida Fabr., roundheaded appletree borer, adults on apple, May 25

Onderdonk, A. F. Webster Groves, Mo. Plectrodera scalator Fabr., banded poplar borer, adult, July 26

Flanders, C. Y. Tribes Hill. Monohammus confusor Kirby, pine sawyer, larvae on pine, March 14

Wadsworth, Leland. Troy. Same as preceding, adult, June 5

Pickering, F. B. Ballston Spa. Same as preceding, June 6

Feeney, James. Meadowdale. Phymatodes variabilis Fabr., variable oak borer, adults reared from oak, June 5

Huxley, F. T. Amsterdam. Desmocerus palliatus Forst., cloaked knotty horn, adults on elder, June 2

State Department of Agriculture. Mount Vernon. Neoclytus erythrocephalus Fabr., adult on maple, June 16

Baldwin, E. A. Schenectady. Euphoria inda Linn., bumble flower beetle, adult, May 30

Brisbin, C. E. Schuylerville. Anomala lucicola Fabr., light loving grapevine beetle, adult, June 21. Also Serica sericea Ill., adult, June 21

Draper, R. C. Rochester. Through State Department of Agriculture. Hoplia trifasciata Say, injuring pear blossoms, from Greece, May 16

Scudder, J. B. Coxsackie. Canthon laevis Dru., tumble bug or dung beetle, adult and dung ball, May 27

Gibbes, R. H. Schenectady. Amphicerus bicaudatus Say, apple twig borer, work on cherry, June 23

Joutel, L. H. New York City. Thelydrias contractus Mots., adult, pupal and larval skins, June 20

Clapp, S. K. Brown Station. Through State Conservation Commission, Agrilus bilineatus Web., two-lined chestnut borer, larvae on chestnut, August 30

Brisbin, C. E. Schuylerville. Dicerca divaricata Say, adult, June 21

Fisher, George. Albany. Alaus oculatus Linn., eyed snapping beetle, adult, June 26

Carpenter, J. S. Marlboro. Byturus unicolor Say, raspberry Byturus, adults on raspberry, May 15

Wilson, Mrs James. Rochester. Attagenus piceus Oliv., black carpet beetle, larvae, October 3. Also Anthrenus scrophulariae Linn., Buffalo carpet beetle, larvae, October 3

Cleveland, P. Scotia. Silvanus surinamensis Linn., saw-toothed grain beetle, adults, April 12

Seiver, W. I. & Co. Angelica. Same as preceding, in flour, May 31

Bates & Broman. Middleburg. Same as preceding, adults, June 20

Diptera

Collins, J. D. Utica. Tabanus atratus Forst., horse-fly, adult, July 14

Kellogg, V. L. Stanford University, Cal. Thecodiplosis piniradiatae Snow & Mills, cotypes on Monterey pine, March 16

Moore, R. M. Rochester. Anopheles punctipennis Say, malaria mosquito, adult, October 6

Siphonaptera

Drew, Miss M. E. Highland Falls. Through State Department of Health. Ctenocephalus canis Curt., dog flea, adult, August 4

Lepidoptera

Todd, Miss Mabel. Gloversville. Euvanessa antiopa Linn., spiny elm caterpillar, larva, June 2

Draper, L. W. Amenia. Same as preceding, June 3

Thomas, M. G. Ticonderoga. Same as preceding, on elm, June 3

Babcock, H. N. Elmira. Same as preceding, larvae, June 5

Morey, C. L. Greenwich. Same as preceding, June 6

Pickering, F. B. Ballston Spa. Same as preceding, on elm, June 6

Zeh, S. D. Hillsdale. Same as preceding, June 6

Russell, C. A. Frankfort. Same as preceding, larvae, June 14

Baker, A. N. Bellport. Same as preceding, June 17

Winchester, M. F. South Amenia. Same as preceding, chrysalids, June 9

Rankin, E. W. Albany. Same as preceding, chrysalis, June 14

Wells, William. Flushing. Basilarchia astyanax Fabr., larva on oak, May 30

Ward, G. E. Ravena. Samia cecropia Linn., Cecropia moth, cocoon, May 6

McEwan, Livingston. Albany. Same as preceding, adult, May 24

Carpenter, J. H. Elnora. Callosamia promethea Dru., Promethea moth, cocoon on lilac, December 9

Hicks, J. J. Jericho. Same as preceding, cocoon, April 25

Darling, Miss F. B. Syracuse. Same as preceding, pupae, April 28

Russell, C. A. Frankfort. Same as preceding, cocoons, June 6

Pierce, Mrs N. A. Solsville. Tropaea luna Linn., Luna moth, adult, May 29. Also Telea polyphemus Cram., Polyphemus moth, adult, May 29

Wheeler, Mrs M. E. East Nassau. Tropaea luna Linn., Luna moth, adult, May 29

Reed, J. A. Watervliet. Telea polyphemus Cram., Polyphemus moth, cocoon and moth, July 15

Huested, P. L. Sparta. Through State Department of Agriculture. Hyphantria textor Harr., fall webworm, larvae, August 25

Bennett, A. T. Tivoli. Same as preceding, larvae on apple, June 9

Scifield, A. G. Hopewell Junction. Same as preceding, larva, September 12

Powers, F. N. Utica. Alypia octomaculata Fabr., 8-spotted forester, larva, June 23

King, F. A. New York City. Same as preceding, larvae on grapevine, July 6

Rich, W. L. Saratoga. Macronoctua onusta Gr., Iris borer, larvae on Iris, July 28

Huyck, J. N. Albany. Same as preceding, August 2

Harris, A. G. North Pelham. Papaipema nitela Guen., stalk borer, caterpillars, July 17

Herrick, C. J. Albany. Xylina antennata Walk., green maple worm, adult, April 27

Horning, C. O. Amsterdam. Same as preceding, larvae on maple, May 30

Westervelt, W. B. Newburg. Same as preceding, larva on soft maple, June 6

Winters, H. B. Brooklyn. Through State Department of Agriculture. Heliothis armiger Hübn., corn worm, larva on corn, October 13

Albright, M. C. West Coxsackie. Melalopha inclusa Hübn., poplar tent maker, larvae on Carolina poplar, June 30

Fremd, Charles. North Rose. Datana ministra Dru., yellow-necked appletree caterpillar, July 20

Brooks, F. M. Athens. Same as preceding, larvae, August 25

Keller, Miss E. L. Eden. Datana integerrima G. & Rob., black walnut caterpillar, larva on pecan, July 28

Bosworth, W. L. Amenia. Schizura concinna Sm. & Abb., red-humped appletree caterpillar, larvae on apple, July 21

Davis, A. G. Schenectady. Same as preceding, young larvae, July 12

State Department of Agriculture. Notolophus antiqua Linn., rusty tussock moth, eggs on box, nursery stock from Holland, March

Tupper, Thomas. Corning. Hemerocampa leucostigma Sm. & Abb., white marked tussock moth, eggs, March 22

Hepworth, J. A. Marlboro. Same as preceding, larva, May 29

State Department of Agriculture. Rochester. Hemerocampa definita Pack., definite marked tussock moth, eggs on poplar, April 5

State Department of Agriculture. West Coxsackie. Tolype velleda Stoll., larch lappet moth, caterpillar on pear, July 25

Machure, G. F. Saranac Lake. Malacosoma americana Fabr., apple tent caterpillar, larvae, June 5

Cox, Townsend, jr. Setauket. Malacosoma disstria Hübn., forest tent caterpillar, larvae, June 11

Humphrey, Miss A. Warsaw. Same as preceding, larvae on maple, June 13

Paladin, Arthur. No. Italy. Bombyx mori Linn., silkworm, cocoons on mulberry, July 21

Niles, T. F. Rye. Through State Department of Agriculture. Alsophila pometaria Harr., fall canker worm, female moths and eggs, November 30

State Department of Agriculture. White Plains. Same as preceding, egg, February 23

Hummer, J. F. Potsdam. Same as preceding, moth, April 26

Smith, J. N. Margaretville. Ennomos subsignarius Hübn., snow-white linden moth, eggs on beech, April 28

State Department of Agriculture. Coxsackie. Ennomos magnarius Guen., notch wing, egg, February 16

Frech, Mrs William. Bayside. Thyridopteryx ephemeraeformis Haw., bagworm, larvae, August 13

State Department of Agriculture. Cnidocampa flavescens Walk., oriental slug caterpillar, cocoon on Japanese maple. Nursery stock imported from Japan, March 23

Van Loan, C. L. Catskill. Sibine stimulea Clem., saddle-back caterpillar, larva, August 30

MacGregor, R. Brooklyn. Same as preceding, September 29

DeFreest, Mynard. Voorheesville. Euclea delphinii Boisd., larvae, August 25

Barden, J. J. Sodus. Phobetron pithecium Sm. & Abb., hag moth, larva, July 27

Burgin, B. O. St Johnsville. Same as preceding, August 14

Struss, Mrs H. W. New York City. Zeuzera pyrina Linn., leopard moth, adult, July 21

Von Schrenk, Hermann. St Louis, Mo. Podosesia syringae Harr., lilac borer, pupa, March 14

Dunbar, John. Rochester. Phlyctaenia rubigalis Guen., greenhouse leaf tyer, moth, January 7

Skinner, R. L. Greenwich. Crambus caliginosellus Clem., sooty webworm, larvae on corn, June 23

Huested, P. L. Port Chester. Through State Department of Agriculture. Mineola indigenella Linn., leaf crumpler, larvae on Crataegus, November 4

Weston, I. A. Syracuse. Plodia interpunctella Hübn., Indian meal moth, adult in graham flour, September 20

Munger, D. M. Glen Cove. Evetria? turionana Hübn., pine bud tortrix moth, larvae on pine, August 29

Dunbar, John. Rochester. Depressaria? atomella Hübn., adults on Cytisus, April 19

McGeoch, A. N. Lake Placid. Through State Conservation Commission. Bucculatrix canadensisella Chamb., birch leaf Bucculatrix, larvae and work on yellow birch, September 7

Steward, Miss M. B. Goshen. Phyllonoryter hamadryadella Clem., white blotch oak leaf miner on oak, October 10

Briggs, J. N. Coeymans. Same as preceding, June 30

Weston, I. A. Syracuse. Tinea pellionella Linn., clothes moth, adult, May 1

Neuroptera

Milligan, A. E. Schuylerville. Corydalis cornuta Linn., Dobson fly, adult, June 29

Hemiptera

Lewis, H. D. Annandale. Tibicen septendecim Linn., seventeen-year Cicada on apple twigs showing oviposition scars, April 13

Lintner, G. W. Summit, N. J. Same as preceding, adult, May 20

Broome, Edward and Robert. Pelham Bay Park. Same as preceding, May 28

Johannsen, J. Raritan Bay Park, Tottenville, S. I. Same as preceding, pupal cases, May 26

Bulson, S. Stony Point. Same as preceding, adults and pupal cases, May 29.

Ward, G. E. Ravena. Same as preceding, adult, May 29
Bolton, A. J. New Rochelle. Same as preceding, June 3
Thomas, G. B. Schuylerville. Same as preceding, June 8
Davey, R. J. Mechanicville. Same as preceding, June 12
Jansen, Frank. Fonda. Same as preceding, June 13
Askins, F. M. Schaghticoke. Same as preceding, June 16
Davies, D. C. Mechanicville. Same as preceding, June 19
Harris, A. G. Pelham. Same as preceding, eggs on locust, July 1
Filer, H. B. Buffalo. Ceresa bubalus Fabr., Buffalo tree hopper, eggs on peach, April 22
Humphrey, Miss E. C. Watervliet. Enchenopa binotata Say, two-spotted tree hopper, nymphs on bittersweet, June 15
State Department of Agriculture. White Plains. Pachypsylla c.-gemma Riley, galls on Celtis occidentalis, May 19
Ferber, Mrs A. J. Rutherford, N. J. Phylloxera caryaecaulis Fitch, hickory gall aphid, adults in galls on hickory, June 2
Wesson, H. W. Eggemoggin, Me. Through Country Gentleman. Chermes floccus Patch, gall on spruce, May 15
Conover, R. T., jr. Bedford. Chermes abietis Linn., spruce gall aphid, galls and adults on spruce, June 10
Clark, Arthur. Garrison. Chermes pinicorticis Fitch, pine bark aphid, adults on pine, June 11
Goodyear, C. W. Tarrytown. Hamamelistes spinosus Shim., adults on birch, June 17. Also Phyllaphis fagi Linn., woolly beech aphis, adults on beech, June 17
Graff, Stephen. Johnstown. Pemphigus ulmifusus Walsh, half-grown galls on red or slippery elm, May 27
Gardner, M. N. Brewster. Phyllaphis fagi Linn., woolly beech aphis, adult on beech, June 15
Howe, Madam. Kenwood. Gossyparia spuria Mod., elm bark louse, adults on elm, May 31
Rogers, J. D. Round Lake. Same as preceding, June 10
Lansing, J. T. Rensselaer. Phenacoccus acericola King, false cottony maple scale, male cocoons on maple, May 18
Hammond, Benjamin. Fishkill. Same as preceding, young on maple, May 26
Briggs, Miss E. M. Oneonta. Same as preceding, adults on maple, May 29
Lawson, T. R. Troy. Same as preceding, June 8
Harcourt, A. J. Kingston. Same as preceding, females and young on maple, July 20
Crossman, L. H. New Rochelle. Same as preceding, August 7
Small, J. W. North Tarrytown. Same as preceding, August 14
Wooster, H. B. Walden. Through State Conservation Commission. Same as preceding, August 16
Unger, H. A. Clinton Heights. Same as preceding, August 17
Buckten, C. W. Mamaroneck. Same as preceding, larvae and adults on maple, August 31

White, Miss J. N. New Rochelle. Through State Conservation Commission. Same as preceding, adults on hard maple, September 9

Nies, C. F. Salamanca. Pulvinaria vitis Linn., cottony maple scale, adults on maple, May 21

State Department of Agriculture. Mount Vernon. Same as preceding, June 16

Kekok, C. C. West Brighton, S. I. Same as preceding, adults and young on soft maple, July 21

Blunt, Miss E. S. New Russia. Lecanium scale, adults and young, June 20

Babcock, H. N. Elmira. Eulecanium nigrofasciatum Perg., Terrapin scale on soft maple, April 8

Yates, M. DeForest. Schenectady. Same as preceding, April 29

Brown, Miss S. A. Unadilla Forks. Same as preceding, June 12

Ward, G. E. Ravena. Eulecanium persicae Fabr., adult on mulberry, May 29

Humphrey, Miss A. Warsaw. ?Eulecanium magnoliarum Ckll., adults, on maple, June 30

Olsen, C. E. Maspeth. ?Saissetia oleae Bern., olive scale, adult on lemon, March 5. Also Chrysomphalus smilacis Comst., smilax scale on ?smilax, March 29. Also Lepidosaphes beckii Newm., adult on lemon, March 5. Also Parlatoria proteus Curt., orange chaff scale, adult on orange, March 5

Harris, S. G. Tarrytown. Chionaspis pinifoliae Fitch, pine leaf scale, eggs on Scotch pine, September 27

Stene, A. E. Kingston, R. I. Diaspis carueli Targ., juniper scale, adults on Swedish juniper, September 27

Thompson, Miss Rhoda. Ballston Spa. Aulacaspis rosae Sandb., rose scale, egg on rose, November 18

Ritch, E. J. Kingston. Same as preceding, April 26

Atwood, G. G. France. Through State Department of Agriculture. Epidiaspis piricola DeGuer., pear scale, adult on pear imported from France, January 16

Ellwanger & Barry. Rochester. Aspidiotus? ostreaeformis Curt., European oyster scale, adult on willow, May 12

Gibson, Arthur. Ottawa, Canada. Same as preceding, adults, October 11

Earl, Mrs E. A. Ballston Spa. Aspidiotus perniciosus Comst., San José scale, young on apple, May 18. Also Lepidosaphes ulmi Linn., oyster shell bark louse, young on apple, May 18

Lane, A. M. Schenectady. Aspidiotus perniciosus Comst., San José scale, young on apple, April 1

Akins, W. J. New Baltimore. Same as preceding, young, August 8. Also Lepidosaphes ulmi Linn., oyster shell bark louse, on French lilac, August 14

Schofield, R. Coeymans. Aspidiotus perniciosus Comst., San José scale, adults and young on apple, September 15

Field, J. E. New York City. Lepidosaphes ulmi Linn., oyster shell bark louse, eggs on balm of Gilead, April 21

Hudson, G. H. Plattsburg. Lygus pratensis Linn., tarnished plant bug, adults on aster, October 8

Yeomans, Albert. Walworth. Poecilocapsus lineatus Fabr., 4-lined leaf bug, work on currant, June 13

Orthoptera

Brown, M. R. Merrickville. Ischnoptera pennsylvanica DeG., June 19

Moore, W. F. Mechanicville. Through Troy Press. Gryllotalpa borealis Burm., mole cricket, August 26

Plecoptera

Robinson, W. G. Greenfield Center. Pteronarcys biloba Newm., adult, May 26

Ephemerida

Lane, B. H. Coxsackie. Hexagenia variabilis? Eaton, June 2

Thysanura

Taber, S. R. Milton. Smynthurus arvalis Fitch, adults on raspberry, May 24

ZOOLOGY

Donation

Mammal skull

Clarke, Dr John M. Albany

Walrus, Odobenus rosmarus (Linnaeus)..... 1

Birds

Publishers of Country Gentleman. Albany

Purple finch, Carpodacus purpureus (Gmelin)..... 2

Jordan, A. L. North Greenbush

Red-winged blackbird, Agalaius phoeniceus (Linnaeus). 1

Paladin, Arthur. Albany

Yellow-bellied sapsucker, Sphyrapicus varius (Linnaeus). 1

Seymour, Miss May. Lake Placid

Water thrush, Seirus noveboracensis (Gmelin)..... 1

Stead, Mrs J. C. Brooklyn

Gannet, Sula bassana Linnaeus, mounted..... 1

Amphibians

Latham, Roy. Orient Point, Suffolk county

Four-toed salamander, Hemidactylium scutatum (Schlegel)..... 1

Fishes (in alcohol)

Bean, Dr Tarleton H. Albany

Golden shiner, Abramis crysoleucas (Mitchill)..... 1
Lake chub, Semotilus bullaris (Rafinesque)..... 1
Creek chub, Semotilus atromaculatus (Mitchill)..... 1
Horned dace, Notropis cornutus (Mitchill)..... 1
Buckeye shiner, Notropis atherinoides Rafinesque..... 1
Spawn eater, Notropis hudsonius (De Witt Clinton).... 1
Mud sucker, Exoglossum maxillingua (Le Sueur).... 1

Invertebrates

Bean, Dr Tarleton H. Albany

Leech, Trachelobdella vivida (Verrill)..... 2

Patten, Mrs M. M. Albany

Sea fan, Rhipidogorgia flabellum (Linnaeus)..... 12

Sanford, Gen. George D. Albany

Tarantula, Dugesiella hentzi (Girard)..... 1

Exchange

Birds

Ward's Natural Science Establishment. Rochester

Black-backed gull, Larus marinus Linnaeus, skin..... 1
Iceland gull, Larus leacopterus Faber, skin..... 1
Harlequin duck, Histrionicus histrionicus (Linnaeus) skin 1
Wood ibis, Mycteria americana Linnaeus, mounted..... 1
White gyrfalcon, Falco islandus Brünnich, skin..... 1
Snowy owl, Nyctea nyctea (Linnaeus) skin..... 1

Purchase

Mammals

Paine, Silas H. Silver Bay

Virginia deer, Odocoileus virginianus borealis Miller, fawn, mounted..... 1
Porcupine, Erithizon dorsatus (Linnaeus) mounted..... 2
Fisher, Mustela pennanti Erxleben, mounted..... 1

Rhodes & Gilbert. Lander, Wyoming

Elk, Cervus canadensis (Erxleben), skins..... 3

Ward's Natural Science Establishment. Rochester

Opossum, Didelphis virginiana Kerr, mounted group.... 10
Harbor porpoise, Phocaena phocaena (Linnaeus), cast... 1
Bottle-nosed dolphin, Tursiops tursio (Fabricius), cast... 1
Fox squirrel, Sciurus rufiventer Geoffroy, skins..... 4

Birds, mounted

Barker, Fred. Parker's Prairie, Minnesota

Pied-billed grebe, Podilymbus podiceps (Linnaeus)..... 5
Black tern, Hydrochelidon nigra surinamensis (Gmelin) 3
Mallard, Anas platyrhynchos Linnaeus..... 3
Least bittern, Ixobrychus exilis (Gmelin)..... 3
Virginia rail, Rallus virginianus Linnaeus..... 5
Sora, Porzana carolina (Linnaeus)..... 5
Florida gallinule, Gallinula galeata (Lichtenstein)..... 1
American coot, Fulica americana Gmelin..... 5
Upland plover, Bartramia longicauda (Bechstein)..... 2
Killdeer, Oxyechus vociferus (Linnaeus)..... 4
Marsh hawk, Circus hudsonius (Linnaeus)..... 4
Coopers hawk, Accipiter cooperi (Bonaparte)..... 3
Red-tailed hawk, Buteo borealis (Gmelin)..... 5
Broad-winged hawk, Buteo platypterus..... 3
Long-eared owl, Asio wilsonianus (Lesson)..... 4
Great-horned owl, Bubo virginianus (Gmelin)..... 4
Ruby-throated humming bird, Archilochus colubris (Linnaeus) 1
Grasshopper sparrow, Ammodramus savannarum australis 5

Paine, Silas H. Silver Bay

Loon, Gavia immer (Brünnich)..... 3
Herring gull, Larus argentatus Pontoppidan..... 1
Black duck, Anas rubripes (Brewster)..... 3
Bittern, Botaurus lentiginosus (Montagu)..... 2
Great blue heron, Ardea herodias Linnaeus..... 3
Red phalarope, Phalaropus fulicarius (Linnaeus)..... 1
Woodcock, Philohela minor (Gmelin)..... 4
Spotted sandpiper, Actitis macularia (Linnaeus)..... 2
Ruffed grouse, Bonasa umbellus (Linnaeus)..... 7
Goshawk, Astur atricapillus (Wilson)..... 5
Duck hawk, Falco peregrinus anatum (Bonaparte).... 4
Sparrow hawk, Falco sparverius Linnaeus..... 6
Osprey, Pandion haliaetus carolinensis (Gmelin).. 3
Kingfisher, Ceryle alcyon (Linnaeus)..... 4

Birds (skins or in flesh)

Jordan, A. L. North Greenbush

Barred owl, Strix varia Barton..... 1

Ward's Natural Science Establishment. Rochester

Ground dove, Columbigallina passerina terrestris (Chapman) 2

Birds' nests and eggs

Paine, Silas H. Silver Bay

Pied-billed grebe, Podilymbus podiceps (Linnaeus), nest and 3 eggs
Bittern, Botaurus lentiginosus (Montagu), nest
Great blue heron, Ardea herodias Linnaeus, nest
Coot, Fulica americana Gmelin, nest
Killdeer, Oxyechus vociferus (Linnaeus), 3 eggs
Ruffed grouse, Bonasa umbellus (Linnaeus), 7 eggs
Marsh hawk, Circus hudsonius (Linnaeus), nest and 1 egg
Goshawk, Astur atricapillus (Wilson), nest
Sparrow hawk, Falco sparverius Linnaeus, nest and 2 eggs
Barred owl, Strix varia Barton, nest
Screech owl, Otus asio (Linnaeus), nest
Great horned owl, Bubo virginianus (Gmelin), nest and 3 eggs
Kingfisher, Ceryle alcyon (Linnaeus), 5 eggs
Kingbird, Tyrannus tyrannus (Linnaeus), nest and 3 eggs
Crested fly-catcher, Myiarchus crinitus (Linnaeus), nest and 3 eggs
Phoebe, Sayornis phoebe (Latham), nest
Eave swallow, Petrochelidon lunifrons (Say), 2 nests
Barn swallow, Hirundo erythrogaster Boddaert, nest and 3 eggs
Red-eyed vireo, Vireosylva olivacea (Linnaeus), nest and 1 egg
Blackburian warbler, Dendroica fusca (Müller), nest
Chickadee, Penthestes atricapillus (Linnaeus), nest and 4 eggs
Bluebird, Sialia sialis (Linnaeus), nest and 2 eggs

Reptiles (casts)

Ward's Natural Science Establishment. Rochester

Rattlesnake, Crotalus horridus Linnaeus, cast..... 1
Garter snake, Thamnophis sirtalis (Linnaeus) cast..... 1
Painted turtle, Chrysemys marginata Agassiz, cast..... 1
Snapping turtle, Chelydra serpentina (Linnaeus) cast... 1

Fishes (mounted)

Paine, Silas H. Silver Bay

Small-mouthed black bass, Micropterus dolomieu Lacépède 1
Common sunfish, Eupomotis gibbosus (Linnaeus)..... 2
Yellow perch, Perca flavescens (Mitchill)..... 1

ARCHEOLOGY

Excavation

By **A. C. Parker** and **E. R. Burmaster**

Lima, Livingston county

Copper beads	20
Arrow points, triangular	7
Flint, worked	1
Crushed pottery vessels, may be restored	5
Celts	5
Arrow points from surface	25
Old type crude shell beads	65
Brass or copper cylinder ring	1
Flat ring, ends tied with cord	1
Worked shell ornament	1
Wampum beads, string of	50
Shell beads, Roanoke style	3
Brass coil	1
Awls	3
Buckskin fragments	5
Paint, quantity of red	1
Arrow points	12
Perforated ball joint	1
Shell beads	5
Triangular arrow points	2
Bird mandibles	3
Portion woven bag, containing many beads	1
Muller stone, fine specimen	1
Brass or copper spiral	1
Large copper ring ornaments of native manufacture	3
Copper beads	25
Fragment woven bag	1
Pitching tool	1
Flakers	3
Arrows, all three from one grave	3
Charred corn box	1
Hammer stone or muller	1
Copper spiral	1
Shell beads	20
Arm ornament containing 640 beads	1
Crude shell beads	21
Bone comb, early contact form	1
Unio shell article	1
Awl, worked tooth, 4 flints	6
Large brass or copper ring ornaments	4
Disk or roanoke wampum beads	9
Large natural made wampum beads	5
Buffalo horn tips worked into beads	2
Brass spiral	1

Long tubular brass ornament 1
The five last mentioned articles on original thong preserved by copper salts
Woven bag fragment 1
Disk beads 94
Copper beads 2
Small brass tubes 75
Copper disk, broken 1
Brass beads 15
Plum pit dice 24
Brass or copper tubes (long) 7
Wampum and roanoke beads 200
Copper beads 6
Fragments of buckskin 2
Bone ornament worked from turtle carapace 1
Unio shell articles 2
Antler "pins" polished 3

By **J. F. White**
Mount Morris, Livingston county
Copper ornament 1

Donation

J. A. Van Denburg. Eagle Bridge
Celt 1
Stone knife 1
Chipped arrow points 55

Clyde B. Hay. Hackensack, N. J.
Collected from South Bethlehem
Arrow points 33
Miscellaneous stone points 16
Spears 6
Fragmentary flints 11

C. E. Durkee. Saratoga Springs
One fragment polished pick 1
Fragment pottery vessel rim 1
Chisel gouges 2
Slate knife 1
Flint points 11
Knife, chert 1
Cutting edge of celt 1
Fragments of points 16
Knives 3
Drills 3
Triangular points 2
Miscellaneous notched points 25
Burnt scraper, notched 1

Holden Collection, Box 1
Bronze buckle 1
Catlinite tube-pipe 1

Perforated stone	1
Copper chisel	1
Skinning knife	1
Barlow knife, Fort William Henry	1
Pipe, with card attached	1
Banner stone	1
Bullet mold	1
Barlow (same as above)	1
Confederate dirk	1
Broken banner stone	1
Huge clasp knife from French Mt	1
Perforated stone	1
Copper hatchet	1
Heart-shaped birch bark, with quill work	1
Key from Fort George	1
Iron hatchet	1
Arrowhead — Dodge Sweet farm	1
Banner stone	1
Needle-stone	1
Perforated stones	
Small box containing shell beads	
Very fine spear points	4
Skinning knife	1
Antique buckle	1
Fine gouge	1
Small box bullets, shrapnel etc. from Fort George	1
Aztec cup, in small box	1
Horn cup	1
1 box miscellaneous minerals	1
1 small box S. C. arrow points	1
Package arrow points	1
2 boxes unidentified arrow and spear points	50

Holden Collection Box 2

Gouge	1
Gouge	1
Pestles	4
Large pestle, Baker farm	1
Discus	1
Iron axe	1
3 iron axes	3
Large stone axe	1
Stone axe — crude	1
Stone chisel	1
Stone hatchet	1
Stone axe	1
Stone axe	1
Iron adze	1
Stone axe	1
Chisel	1

Dressing stone..... 1
Gouge..... 1
Gouge..... 1
Broken pestle..... 1
Iron axe, restored handle..... 1
Fragments steatite vessel..... 2
Celt..... 1
Fine celt..... 1
Brick from Ticonderoga..... 1

Gordon, Patchogue, L. I.

Worked oval stone..... 1
Notched sinkers..... 4
Grooved axe, crude..... 1
Chipped stones..... 4
Celt belts..... 4
Celts, fine specimens..... 3
Celts, crude..... 5
Chert arrow points.....
Reject flints..... 32
Ring of European trade wampum..... 1
Chisel..... 1
Pipe — complete..... 1
Triangular points..... 97
Long slender points..... 25
Chert points, miscellaneous..... 48
Fragments of clay pipes..... 3
Miscellaneous flints..... 30
Ohio arrow points..... 13

ETHNOLOGY

Seneca specimens

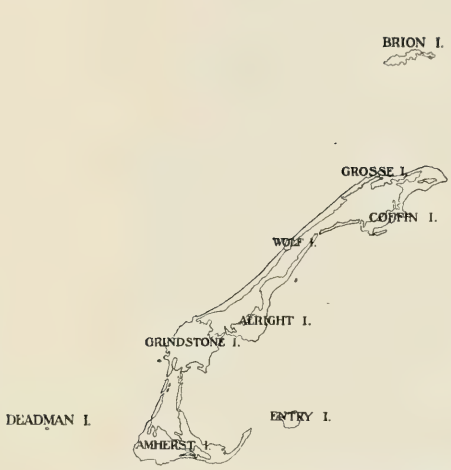
Flat corn basket..... 1
Carrying basket..... 1
Game bowl..... 1
False face..... 1
Wooden spoon..... 1
Headdresses..... 3
Wooden bowls..... 2
Sap tubes..... 5
Bow and arrows..... 6
Wooden spoons..... 2
Rattles..... 4
Wooden trough..... 1
Brooches..... 30
Earrings..... 2
Decorator's tools..... 15
Bracelets, silver..... 2
Arm bands, silver..... 2

Onondaga specimens

False face	1
Husk dolls	2
Pipe and decorated stem	1
Brooches	6
Earrings	2
Dice of peach pits	6
Brooches	6
Silver earrings	2

Cayuga specimens

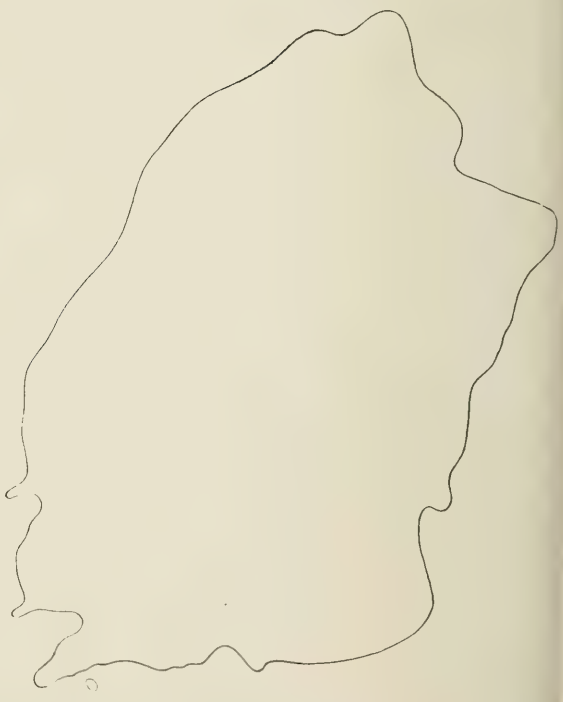
Baby board	1
Log house	1



Present outline. All long arms are sand

Outline at 5 fathoms

Cutline at 10 fathoms



Outline at 20 fathoms

Magdalen Islands. Outlines indicating their loss of area by wave action with concurrent submergence. All are in the same scale.

NOTES ON THE GEOLOGY OF THE GULF OF ST LAWRENCE

BY JOHN M. CLARKE

THE DEMOISELLES OF ENTRY ISLAND

On the Magdalen islands in the Gulf of St Lawrence the higher land elevations are mammiform hills which rise everywhere with striking symmetry and entire absence of irregularities into softly contoured grassy domes. I have termed these hills *demoiselles*,[1] taking the name from Demoiselle hill, one of their number, which fronts the sea on the east coast of Amherst island. Over all the larger islands these pretty hills rise to relatively notable heights; except for them the islands are flat, low-lying plateaus of sandstone and sand dune, but the rounded heads of the demoiselles, showing none of their rocks except where eaten into by the sea or weather, command the eye by the abruptness with which they rise from the plain. Wherever they occur all have the same general direction and relation to each other. Their course lies generally northeast-southwest, like the trend of the island group itself. On the broad central part of Amherst they lie in well-nigh parallel rows, but their height is greatest on Entry island. St Lawrence hill (so named by S. G. W. Benjamin, author, forty years ago, of some fascinating sketches of these islands) approximates 670 feet and is the highest of all and the most symmetrical in the remarkable array of demoiselles in that island to which I desire, among other things, to direct special attention. On Amherst these hills lack some of the elements of symmetry and beauty which are presented by those on Alright and Entry islands. It is in the latter they attain their most striking appearance and on Alright their greater isolation makes them a somewhat more effective feature to the passerby. Indeed the passer seldom sees the hills of Entry except as a skyline, for this island lies apart from the rest of the group and from all regular connection with them. The steamer threads the precarious channel between the sand spits of Amherst and Entry but the hills of Entry are on its farther side and face the gulf. In my general description of the islands and their geology the nature of these hills was discussed and some suggestions made as to their origin, but much was left unsaid. Since then I have had opportunity to study the structure of Entry island, which I had not before visited.

[1] Observations on the Magdalen Islands, 1911, p. 12.

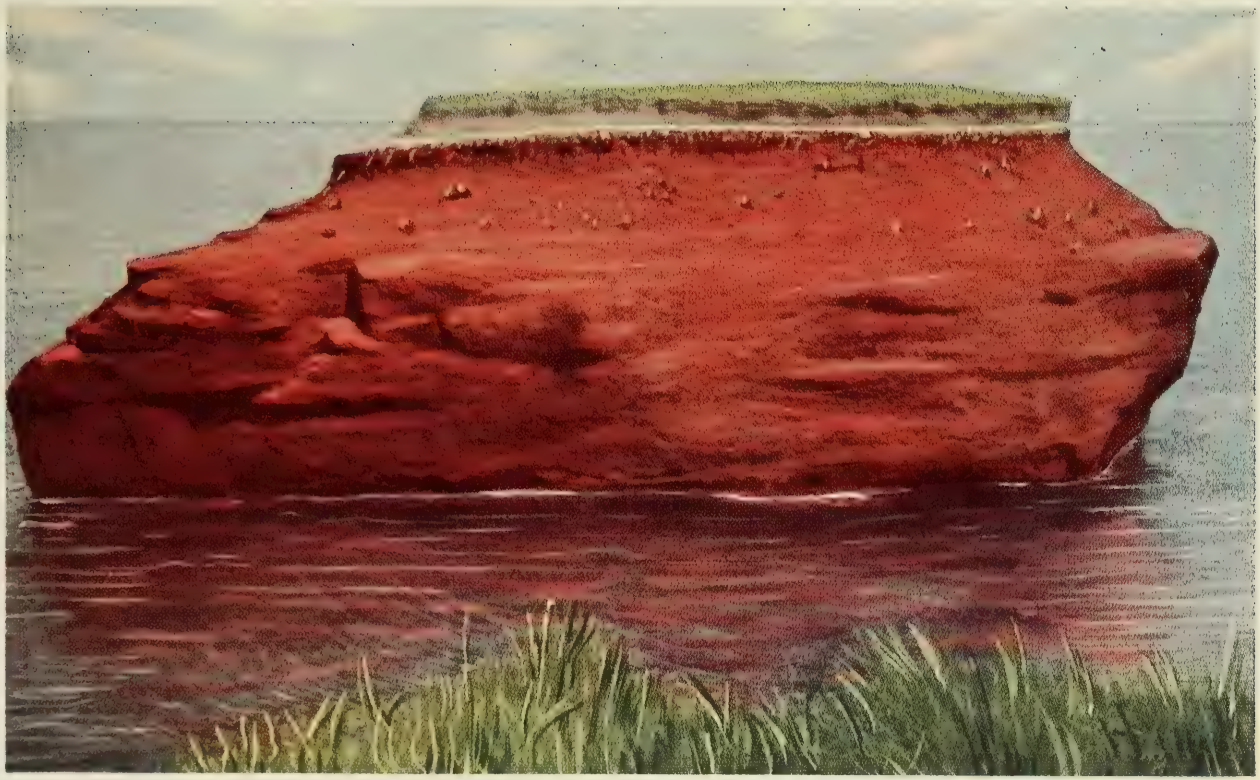
One reaches Entry from Amherst harbor by the help of a fisherman's shallop, and though isolated from the rest of the little archipelago, it is easy enough to reach in a summer's breeze, less easy in a summer's blow, and the island is quite off the world in the gales that blow up without warning on the uncertain gulf. Entry is the park and arcadia of the Magdalens. The very beauty of its isolation, the fertility of its soil, the alluring grace of its contours, the air of relative prosperity among its slender population, invite to studious repose. It is a little seagirt domain where no one asks a favor of the outside world, save to get there and to get away again. Its proportions are slender, measuring two miles in diameter both north-south and east-west; taking on a rather five-sided shape, with the east shore due north and south. From its northwestern angle a long sand spit reaches out toward the great nine-mile spit from Amherst (Sandy Hook), these long arms almost clasping hands across the narrow channel in which by fair weather lies the steamer's path.

Entry island in profile, seen from the west

The eastern shore is lined and buttressed by the range of demoiselles. The sea has eaten into them making all that shore a row of sheer and inaccessible cliffs. The island remains, it may well be said, because these hills have defied the storms of the gulf and have guarded the lower lands behind them against the tooth of the sea.

The views from the shore cliffs and uplands of the island are of wondrous sweep and beauty — toward the west and north the cliffs and low-lying shores of the other islands, the gray rocks of Amherst, the red walls of Grindstone, the more distant hills of Alright fading with distance into the blue sands of Grand Entry and Old Harry; on the south the misty outline of St Paul's island and Cape Breton fifty miles away, and at the east the vast expanse of waters of the gulf. Of a fair day in summer the island is a gem of emerald in an idyllic Aegean setting. In autumn's storms it is a foothold against the seething uproar of the gulf, and in winter it lies chained to its sister islands by bands of ice which sever it and them from the world outside, save for the cable and the marconi.

History and settlement. In my previous paper I have taken occasion to refer incidentally to the fact that since the days of the



Entry island — Insulated sandstone table on north shore; showing white sand layer and pebble bed

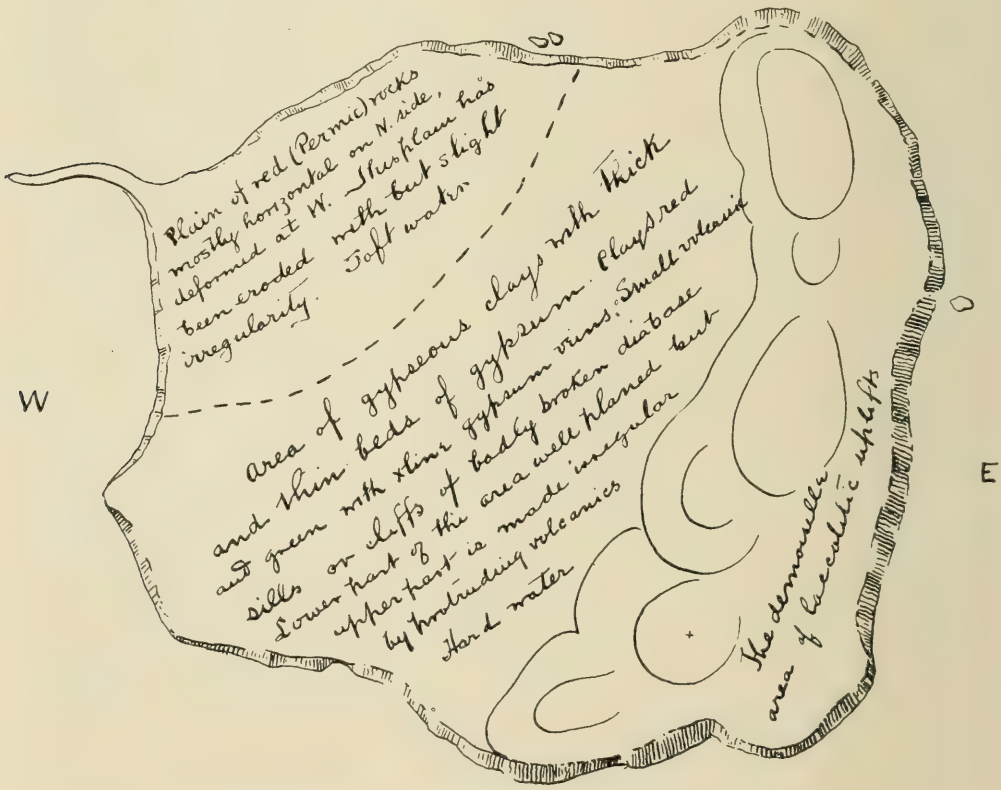
earliest charts on which this island has been given any designation, its name has been unaltered. It was the Ile de l'Entrée to the skippers of the sixteenth and seventeenth centuries. Standing at the door of the island cluster, as the navigator swung from the southward of Newfoundland through Cabot strait, its name registers its office. The records of French settlement on Entry have entirely passed away. Today the population is wholly Scotch and Scotch-Irish and the old stock is the Cassidys, Dixsons, McCleans and Collinses, stock which came in from Nova Scotia a century or more ago and has multiplied almost wholly by intermarriage. There are about thirty families on the island, each related in near or far degree to all the rest and it is commonly said that no outsider has settled in this community in time out of mind. The laws of eugenics which discountenances such close inbreeding is here honored in the breach and the youth of the place instead of weaklings, anemics and decrepits, are sturdy and wholesome. For every human head there must be five head of fine cattle, and milk is actually freer than water, for potable water is scarce; if one will not drink milk then let him drink cream.

The settlers have built their homes for the most part under the lee of the eastern hills, and thus away from the most fertile parts of the ground. So from the beach at Northwest point two wheel ruts crunch their way over buried walrus bones, wander through the grass, bounded on one side, as they pass over the badly drained plaster soil, by fens and bogs sheeted with fleurs-de-lis, on the other by outside cellars made of an overturned whale boat sawed in twain or opened at the side, turfed over on keel, here and there a Barbados puncheon for the geese, till they reach the southeast cliffs; this is the only road the island boasts.

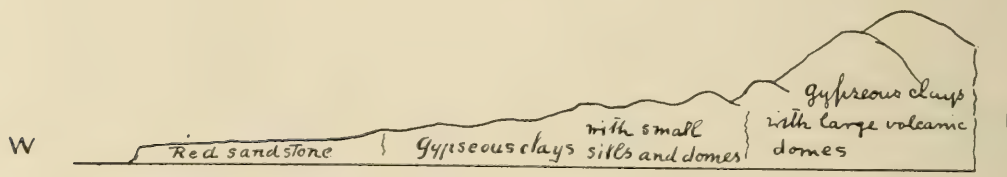
The farmer-fishermen are all tenants of the proprietor — the estate of Sir Isaac Coffin. No land is held by them in fee; notwithstanding the efforts made by the islanders and their friends in the Quebec Parliament to exact concessions from the proprietor to enable freehold, the settlers of Entry have taken no advantage of these concessions; and all the surface of the demoiselle hills is still unleased crown land, pasture to all the community.

The soil divides itself in quality in accordance with the rock that lies beneath it, for it is all residual. Hence over the thin soil of the larger demoiselles at the eastern side there is only grazing for the sheep and cattle; on the lower slopes of the mid-island, where lesser volcanic domes are mingled with the sink holes and roughened sur-

face of the gypseous clays, there is grass in plenty and much soil deep enough for oats and potatoes; but it is on the low plateau of red sandstone near the west and north where the soil is of extraordinary richness, and grain, potatoes and gardens grow to a fulness restricted only by the shortness of the season. The fertility of this soil is barely tried by the inhabitants; on the lowlands it is hardly scratched from year to year to invite the less exhausted parts to the top — but withal, with minimum of labor, always reluctant, it yields enough; the people are fairly well to do and want is unknown among them.

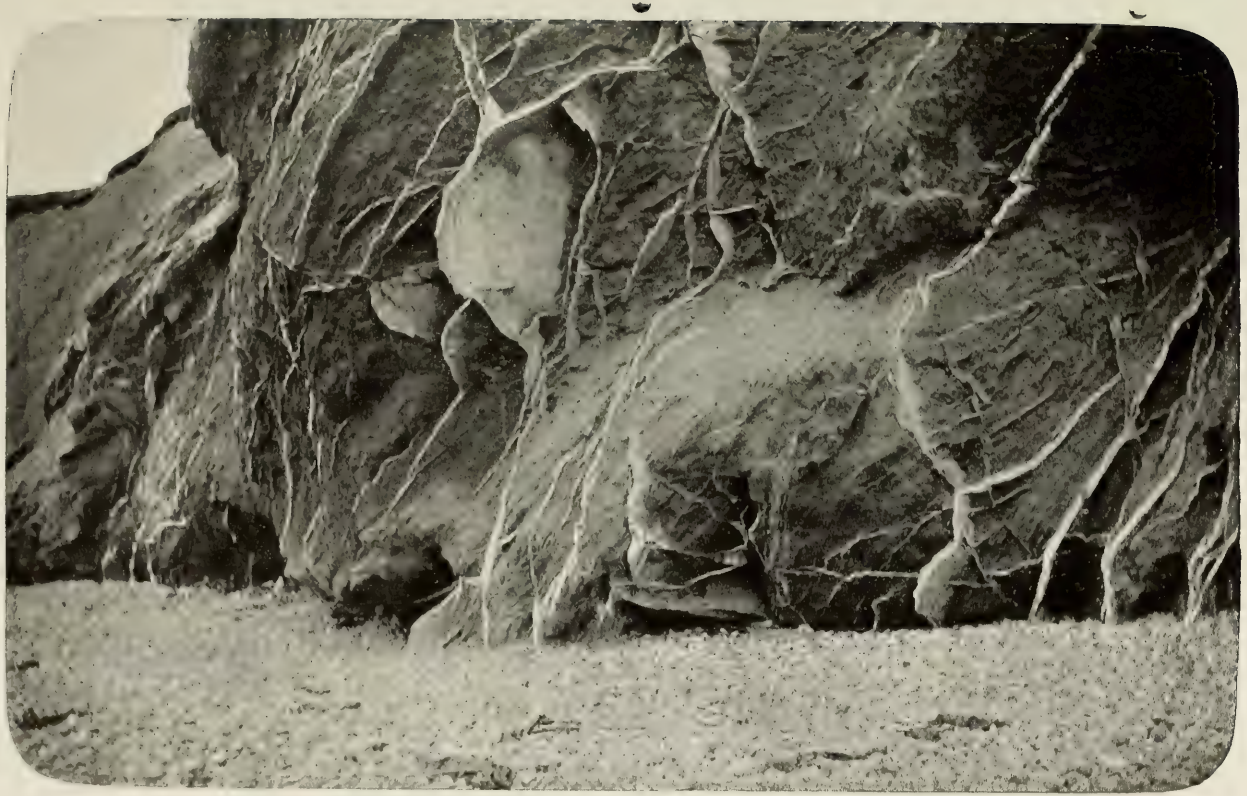

W
E
Plain of red (Permic) rocks mostly horizontal on N. side, deformed at W. Hudsonian has been eroded with but slight irregularity
Soft water
Area of gypseous clays with thick and thin beds of gypsum. Clays red and green with xline gypsum veins. Small volcanic sills or cliffs of badly broken diabase
Lower part of the area well planed but upper part is made irregular by intruding volcanics
Hard water
The dominantly area of basaltic cliffs

Sketch plan of Entry island and its topographical divisions



West-east cross section of Entry island

Added to all the possibilities of the soil are the treasures of the sea; the seal, the lobster, cod, herring, mackerel and cod again, each in its season — a rich horn of plenty for any one who will, at some cost of rough work, reach out and take. Two hundred thousand



Entry island. Gypseous rock with veinlets of crystalline gypsum.

Entry island. The gravel layers within the red sandstone, exposed by wind erosion of the overlying beds.

Entry island. A comfortable home, with demoiselle topography in the background.

lobsters were caught on Entry in 1911, but it is easy work to drop a lobster trap and pull it up again loaded. Even at three cents a lobster this means something for the frugal islanders. And yet the other wealth of the sea might be made vastly more productive than it now is. But why make muckle mair? This is the Isle of Repose, its treeless slopes and plain, the shadeless groves of the stagyrite.

Topography. The contour of Entry is suggested by the accompanying east-west cross section which may be applied to the plane map.

Red sandstone plateau. The red Permic sandstones of the lower plateau are restricted to the northwest corner on both sides of the sand spit and here they are displayed in all their brilliance of color, made more effective than elsewhere on the Magdalens by the way in which the winds have stripped it of its overlying soil. I have before directed attention to the constitution of these, the latest sediments of the islands, and may here only restate that the striking band of glistening white residual sand lying everywhere beneath the vegetable mold is here brilliantly developed in every cliff section. The layer of angular diabase pebbles which lies directly beneath this white sand, is even more conspicuously displayed on Entry than anywhere else on the islands and there are broad areas on the north side where soil and white sand have been torn away by the winds, exposing this layer of angular gravel in very striking display. This widespread deposit lying on the summit of the red sandstone plateau and incorporated into it points to an obscure but rather extraordinary phenomenon, as though a final stage in the deposit of the sandstone had been the sweeping over the sea floor of an extensive mass of volcanic debris. From any knowledge I have now I dare not say that it points to a contemporary outburst of volcanic debris, or to an overriding tidal wave which may have even covered the low cliffs after they were raised to their present elevation.[1]

[1] The tidal wave action suggested is not too remote. We have evidence at hand that such things still happen in the gulf. On January 7, 1912, the sea rose suddenly in the gulf at 7 p. m., a few hours after high tide, and swept all the lower levels of the Gaspé coast from Cape des Rosier to Percé, causing much damage on the beaches, submerging the stores and other buildings on the "point" at Gaspé Basin and rising to a height of six to eight feet above highest tide. The wave was not followed by another and the water subsided promptly. The action suggests a submarine earthquake of slight moment in the northern gulf, quite possibly some dislocation along appalachian fault lines in the older rocks beneath the upper gulf, but the

Beneath the soil and on the pebble bed lie the bones of walrus in considerable quantity all about the northwest point. I have referred to the occurrence of these in similar position on the other islands. They date back to a century and more ago when the walrus was regularly hunted on the islands, being driven upon the low shores from the ice pans and slaughtered at leisure by the fishermen. Over these bones the soil has formed to a depth of several inches.

The sea has cut away this rock with great rapidity, and is yearly changing the outline of this northwestern shore. When Mr S. G. W. Benjamin wrote his inviting sketches of the islands[1] he gave a picture of two rock pillars off the north shore, long known as the "Old Man" and the "Old Woman." They fell under the waves some twenty years ago, and since their destruction new rock tables and monuments have been carved from the island mass.

The volcanic-gypsum belt. This area makes a broad belt across the island and its topography is that quite characteristic of many gypsiferous regions — a rather badly broken surface, due in no small part to hydration and solution. It is a region of short drainage ways leading down from the hills and running into or through small bogs and marshes, blind sink holes, irregular and formless knolls. But it is for the most part a fairly fertile soil. In geology this belt is composed of gypseous clays and more solid masses in extreme disorder traversed by veins of the crystallized sulfate, the rock masses varying greatly in color from greens and grays into purple-red and pink. While the absence of an orderly bedding is a very evident feature of these extensive deposits there are places where the beds are clearly arranged in horizontal layers with alternating colors. I have here given an illustration in approximately correct tints of a cliff exposure where light pinks and blue grays produce a very surprising color effect. This is on the south shore. With and among these gypseous beds are frequent igneous masses exposed

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seismograph at Albany failed to record any such motion on the day mentioned. Such a single wave of greater magnitude might well have washed the beach debris over the red sandstone cliffs by a single pulsation affecting simultaneously all these low cliffs of all the islands alike, burying and killing the grass with its mantle of gravel which has eventually worked its way down into the decomposing rock.

[1] The Atlantic Islands as Resorts of Health and Pleasure, chap. 4, 1878; The Cruise of the "Alice May"; the Century Magazine, 1884.

Some recent magazine articles by Yeigh and by Amy refer to these rocks as still standing — statements quite comparable in accuracy to many others regarding the islands that these short trip artists have chosen to put down.

Entry island — Gypseous cliffs on south shore.

sometimes as erect dikes of diabase, deeply rotted and at others thin single sills lying at steep angles and constituting the projecting points of the rocky shore. In the midst of these volcanic-gypsum masses, however, are well-stratified green and gray sandstones, exposed most plentifully nearer the contact with the soft red sandstones at the southwest of the area; and in the very heart of the gypsum clays I have located in the midst of great disorder of the strata, dolomites and shales carrying fossils of the same species as those which have been described from Grindstone island. The combination of rocks here is not unlike that on Grindstone island, and elsewhere in the archipelago, but it is more forcibly expressed. The gray sandstones prevail in greater extent on Grindstone and Amherst, and on the former the fossiliferous rocks are found in close juxtaposition to the gypsum. There is on Entry no such development of the commercial gypsum as on Grindstone but the same disordered condition of the gypseous clays and the same intimate association of these with volcanic intrusions. This volcanic-gypsum area is the foreland of the distinctively volcanic demoiselle range of hills; its volcanic intrusions are not conspicuously dome-shaped, but isolated single dikes or sills with no contact effects except those indicated by the existence of the gypseous masses. Here, as on Grindstone, there are many evidences of angular diabase blocks entirely inclosed in gypsum, forming a diabase conglomerate with crystalline gypsum cement. The dislocations of the sandstones and limestones are purely local and of slight extent. It is quite evident that for the red sandstones the horizontal position general in all the other islands is normal here, though these are somewhat out of place on the west shore; and likewise the gray sandstones, elsewhere horizontal, are here thrown into a steep dip where they appear on the south. The disorder of arrangement shown in the cliff sections of this belt is expressed by the irregularities of the surface of the ground.

The demoiselles. This belt of breasted hills begins at the north, forms all the eastern third of the island, spreading a little westward at the south. The most impressive and largest are at the north but it is toward the south that the number is greatest. In a certain sense they are arranged in a single row close against the sea and into their substance the sea has eaten its way, but at the south lesser hills spring up about the base of the larger, becoming smaller in size as they recede from the main series, but always in this more diminutive form retaining their perfect symmetry. I

Sky line and south-east sea front of demoiselles, Entry island

have not attempted to enumerate these demoiselles; the number of their summits seems to depend on the angle at which they are viewed. Often one of the larger, seen from one point, resolves itself into duplicate curves if looked at from another. In all the curves are of essentially the same arc, large and small, and their individuality is more pronounced than on the other islands.

In respect to their geology these demoiselles are to be regarded as more pronounced expressions of the conditions presented in the volcanic-gypsum belt, the volcanic form herein being developed in topography freer of complication with associated rock masses. Yet it is important to avoid the conception that there is any real distinction in composition or genesis between this region of hills and the foreland. The sea has cut well into the heart of these demoiselles and the weather has eaten into their surfaces; and so far as I have observed the volcanics here are accompanied and often overburdened by gypseous deposits alone. The volcanic masses are lenses composed of palpably curved layers and it is this curvature into domes with quaquaversal dip that has produced the contours of the hills. The bedding of these masses is sometimes better defined in one part of a given section than in another, and in no case that I have observed is the volcanic mass free of its overburden of gypseous rock save where meteoric agencies have apparently weathered it away and brought to light the crumbling curved top surface of the diabase. So on all this steep eastern shore section of the demoiselles there are high cliffs of gypse-

Entry island. The northern demoiselles.

Entry island. Surface of demoiselle showing loose volcanic blocks.

Entry island. Outside cellar made of half a whale boat.

ous rock as well as of the volcanics, and it becomes very evident to the observer that the igneous masses have been exposed in their surface contours by meteoric solution of the gypsum overburden. That this is the process of removal of the gypseous rock is made clear by its presence in the shore sections of masses, interstitial between the laccolitic volcanics in cliffs which equal in height the volcanic domes themselves; and for this reason I am disposed to believe that the progress of time will bring the volcanic domes into even stronger topographic contrasts. It is to be presumed that the intrusive masses are not all at the same horizon in the rocks and that the interstices or intervals between as well as for the most part the surface over them is occupied by the gypseous masses. This part of Entry does not however show certain other accompanying and contact effects of the laccolites which are shown

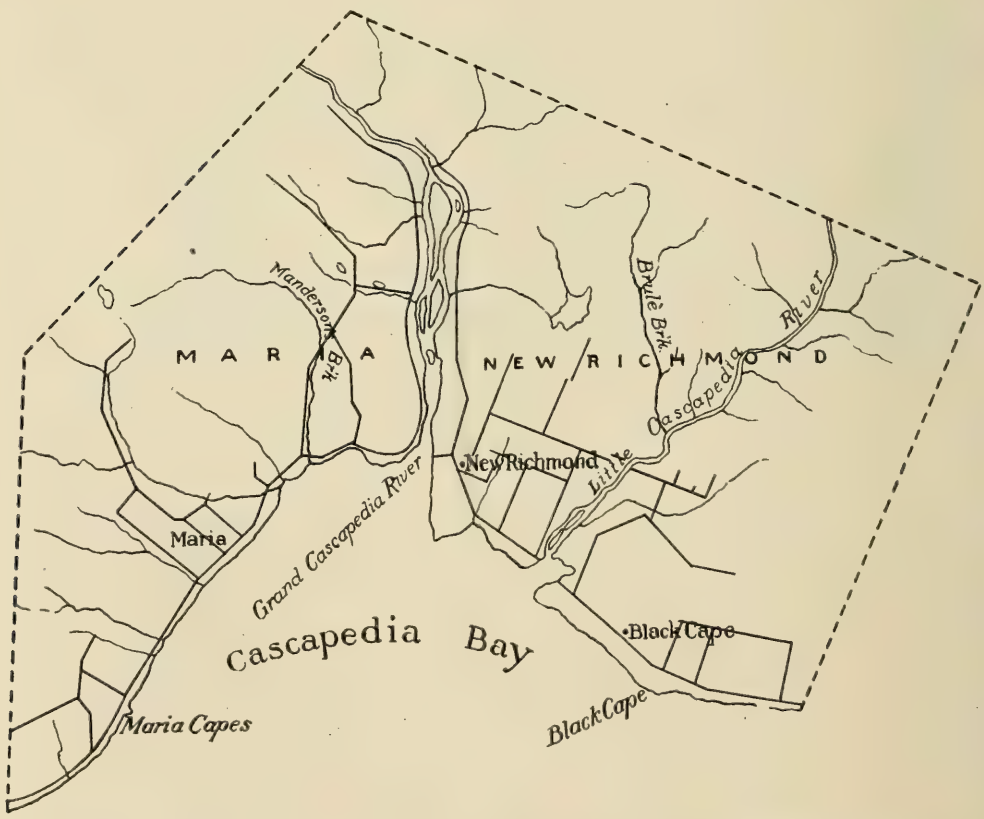
Curved volcanic layers in a section of a demoiselle, east coast of Entry island

in the rest of the islands. These I have elsewhere referred to and they have chiefly to do with the relations of the laccolites to the gray sandstones which are best displayed on Grindstone and Alright islands. On Amherst island it is made very clear that the red sandstones are of later date than the gray, for they lie unconformably over them. But on Grindstone island the red sandstones pass laterally into the gray and much harder sandstones of Point au Meule, the steamer landing at that place. Point au Meule is a demoiselle exposing no igneous core; the gray sandstones alone compose the sea cliff which rises well nigh to the top of the dome. This hardened and highly silicious sandstone mass is soon replaced by the gypsums at the north as it is by the red sandstones at the south. Similar phenomena are seen in the shore domes on Alright, the bolder heads displaying gray sandstone fronts, and in these

cases I believe the overburden of the laccolites is sandstone which has been lifted and in some measure compacted and altered by the igneous lenses beneath. It is not to be understood that these expressions of contact change are the only ones here appearing. The gypsum overburden is also evident on both islands, but the greater resistance of compacted sandstone to the wear and tear of the sea and weather has made these presentments conspicuous, while they are absent on Entry because the ingredients are wanting, the gray sandstones being only very sparsely represented.

A REMARKABLE SILURIC SECTION ON THE BAY OF CHALEUR

This is a preliminary note in regard to a Siluric section of apparently extraordinary thickness exposed along the north shore of the Bay of Chaleur, just east of the mouth of the Little Cascapedia river. The prosperous village of New Richmond lies here



Sketch map of Cascapedia bay and rivers, Bay of Chaleur, giving location of the Black cape section

in the broad depression of the Grand and Little Cascapedia rivers. In the valley of the two rivers the rock series lies deeply buried, but crossing the Little Cascapedia eastward, the rock comes to the sea

Entry island. South end of demoiselle range, lighthouse on summit.

Entry island. The road.

Entry island. Quaking bog or circular water hole overgrown with vegetation. Such solution pits are common between the demoiselles.

front beginning a section which extends continuously along the shore for more than two miles. This section practically ends at the east in a volcanic cliff known as Black Cape and as the same name has been applied to the post-town on the cliff, the section may be designated the *Black Cape section.*

When the late Doctor Ells and his aides mapped this part of the Gaspé peninsula the rocks on this stretch of shore were registered as part Siluric and part Devonic. Their variations in dip were recorded, but little clue was given to the stratigraphic and paleontologic importance of the peculiar development of the series.

It is well to record here, in passing, some recent determinations in the distribution of the paleozoic rocks in the New Richmond region in order to indicate the general condition in which the Siluric belt is involved. The plain between the rivers referred to is an elevated submarine or barachois bottom and is notable for its fine exposure of raised beaches on the sea front at New Richmond village, carrying shell banks which stand at a height of 20 feet and dip eastward about 3′ in a 100′. The shells, mostly lying vertical in the clay as they were lifted out of the sea, are: Mya arenaria, M. truncata, Macoma sabulosa, M. balthica, Saxicava rugosa, Seripes groenlandicus; and the gastropod Chrysodomus despectus.[1]

For a distance of five miles back from the sea front of this plain there are few, if any, rock exposures, but the Carleton mountains lie behind and about it in the form of an amphitheater, the nearer ridges of which are essentially composed of ledges of the red sandstone and conglomerates of the Bonaventure formation.[2] At the west, on the farther bank of the Grand Cascapedia gray unfossili-

[1] Identified by Dr H. A. Pilsbry.

[2] Doctor Ells, in his maps of Gaspé and accompanying reports thereon, endeavored to subdivide the general mass of red sandstones and conglomerates which had been broadly grouped together by Logan under the name "Bonaventure formation," into a lower (Devonic) and upper (Carbonic) element. I believe entirely in Doctor Ells's close approximation to the facts in this expression of the value of the Bonaventure formation, but admit my conviction that an actual boundary between these elements can be located only with great uncertainty. It has been my practice to refer to the formation as a whole as of Devono-Carbonic equivalence and there is not, to my observation, any unconformity or change of sedimentation sufficient to justify a conception of discontinuity of sedimentation. Doubtless sections which I have not seen came under Ells's observation and I disavow any intention to discredit the determination of so admirable an observer as he. The truth is sufficiently stated in the admission of Devono-Carbonic age of

ferous limestones of Siluric age are exposed at various places about five miles from the mouth of the river and thence north. The tremendous unconformity between these highly inclined Siluric limestones and the essentially horizontal Bonaventure conglomerates is seen at every contact, but it is nowhere more forcibly pronounced than at the "Antimony mine" which lies seven miles back of New Richmond among the Carleton mountains. Here the unconformable formations mentioned have parted or been spread apart and the interval is filled by a "vein" or other deposit of quartz having a width of eight to twelve feet. Where best exposed this quartz carries a very considerable amount of diffused stibnite and along certain planes of the deposit the stibnite is concentrated into solid seams some of which are several inches in width and of notable extent. No trace of the Devonic in place has presented itself near these contacts surrounding the plain,[1] but among the loose pebbles and boulders which have been used in the construction of the Montgomery Company's breakwater at the west side of the New Richmond plain — material which has been gathered from the farm fields — are blocks of Devonic sandstone filled with Leptocoelia flabellites and Rensselaerias; the latter are unlike any species yet known from the Gaspé sandstone, but are allied to, probably identical with, species occurring in the Lower Devonic Moose River and Chapman sandstones of Maine and the Dalhousie beds of New Brunswick (cf R. atlantica and R. stewarti).

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these rocks. The Ells maps, for the reason intimated, become rather hard to read in the field because of the inclusion within the single Devonic color the lower part of these red beds with the other very different beds of earlier Devonic. To make Doctor Ells's conception of his Devonic unit clear in this place, his definition of the term as applied to his Gaspé maps is here given:

> The Devonian consists principally of moderately coarse gray conglomerates, sandstones and shales, though red beds occur at several places. The largest area is that of the Great Cascapedia which is probably continuous with that of the lower Restigouche, though largely concealed below Scaumenac bay by the red beds of the Lower Carboniferous. The beds of the Cascapedia though containing abundance of corals and brachiopods at several points have not so far yielded the rich flora and vertebrate fauna of the Campbellton and Scaumenac areas. This area is apparently separated from the more eastern or Gaspé area by ridges of Silurian and older rocks. The beds of Scaumenac bay and eastward probably represent the upper portion of the Devonian system, while those of Campbellton belong to its base.

[1] There are outcrops of dark shale with some gray sandstone on Brulé brook near the Little Cascapedia which Ells regarded as Devonic. No fossils have been found in them. The Siluric-Bonaventure contact noted above at the Antimony mine lies far within the Devonic area indicated by Ells's map, in fact not far from his Siluric-Devonic contact.

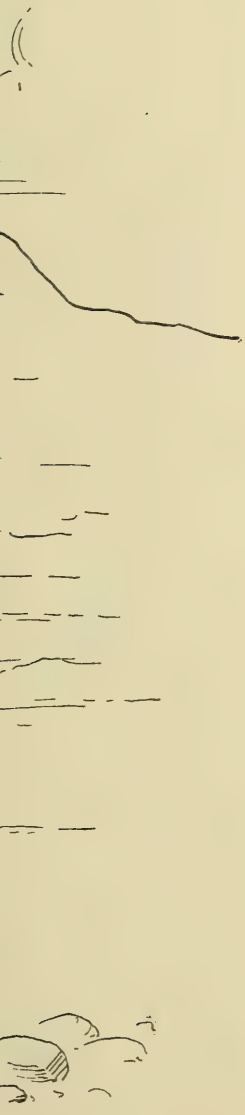
Fish remains similar to those of Scaumenac bay (Migouasha) twenty-five miles west, are reported to me by trappers as occurring about ten miles up the Grand Cascapedia, a statement I have no present means of verifying. In my judgment the brachiopods cited help to substantiate Doctor Ells's view that the Devonic basin here was separated by uplifts of earlier rocks from the Gaspé sandstone basin at the east and was probably continuous with the Devonic basin at the west carrying the Migouasha fish beds. In a previous paper I have pointed out the probable occurrence of the Lower Devonic in the Migouasha-Restigouche region with the species Cyrtodonta gratia and Schuchertella, while the Leptocoelia and Rensselaeria here mentioned indubitably point to its presence not far away.

The Siluric section now in consideration begins not far from the southeast angle of the mouth of the Little Cascapedia and, as already stated, continues without any material topographic break as far as Black cape, a distance of a little more than two miles along the bay shore. The rock strata are almost uniform in their upright attitude throughout their extent, pitched high with steep inclination for the most part to the south-southeast. Ells notes a variety of dips, some to the south-southwest and varying in angle from 40° to 75°; yet westerly dips are unusual and rather restricted in extent. This change in direction of strike is a deformation of slender magnitude. My inspection of the entire section is by no means a thorough one, but a watchful eye for suspected displacements and duplications has failed to detect any, and if such are present they are certainly veiled in parallel unconformities. Reappearances of strata of similar lithologic character are evident, but it is not certain that their fossils are alike. I desire to make all reservation necessary regarding possible duplication in the section, for the thickness of these Siluric beds, estimated apart from such possibilities, is very great, several thousand feet at all events. Yet it is well to recall in this connection that the Canadian geologists who have traversed the interior waterways of this great peninsula record the very great extent of the Silurians all through the region and inferentially their correspondingly great thickness. The upturned edges of these strata are ragged and much eroded. Though they are not here visibly overlain by the later deposits an open cleft on the face of the cliff near the middle of the section, three feet across and twenty feet high, is filled with fine red sandstone of Bonaventure age which has filtered in from above and lies now in oblique saucer-shaped layers, its color in striking contrast to the blue grays of the adjoining vertical limestones.

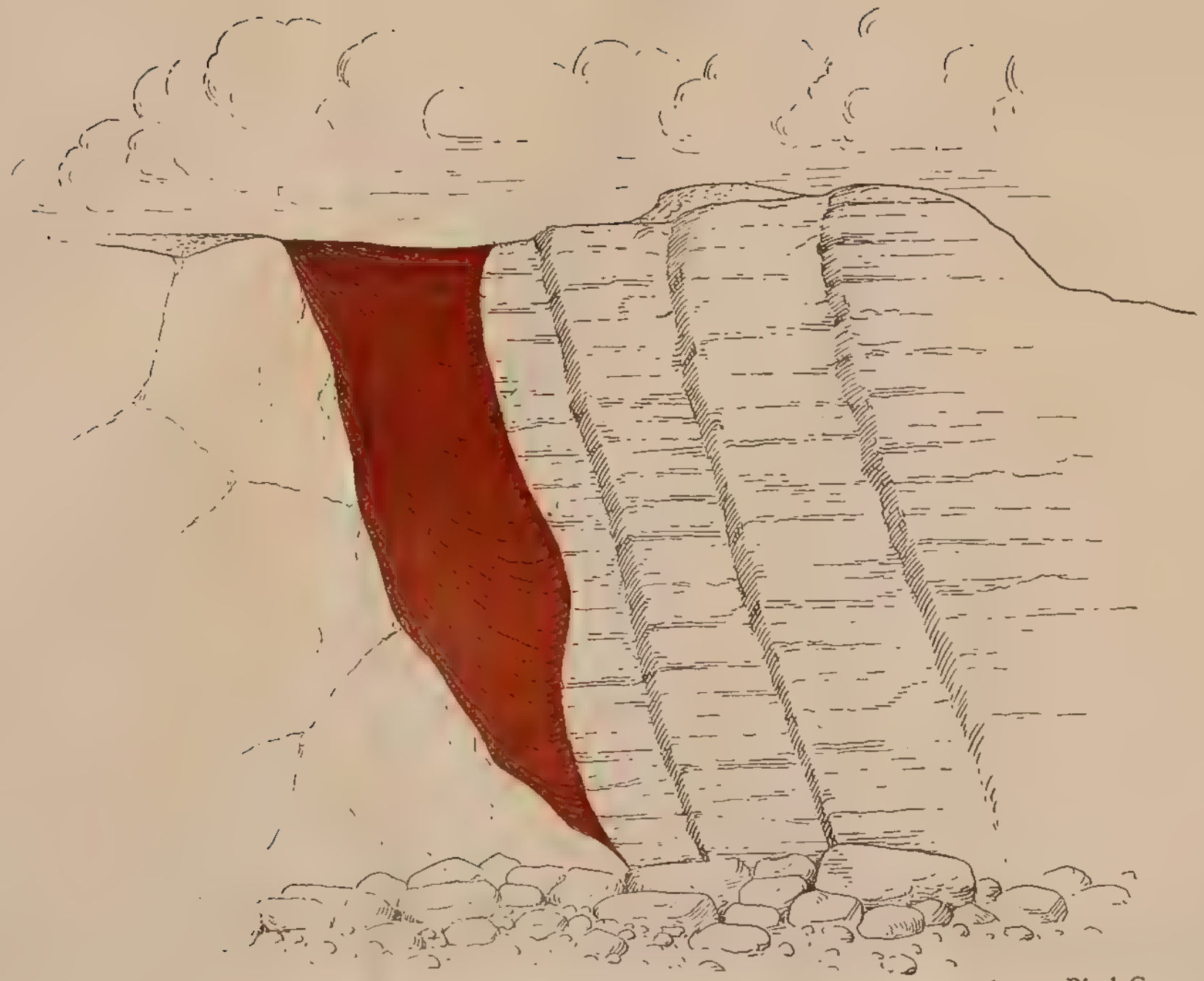
In describing this section we begin at its base near the east shore of the Little Cascapedia, for the position of the coral heads indicates that there has been inclination of the strata without overturn and that in accordance with this inclination the base of the section is at the west.

The lowest part of the rock section is on the front of the Pritchard property. The strata are greenish, highly nodular lime shales, very compact and heavy bedded, weathering out into irregular and gnarled shapes. These alternate with more highly calcareous shales and compact limestones of red and ochreous tints. These compact limestones contain Stricklandinias of great size (S. gaspensis Billings) and in great number. Often this brachiopod is as large as one's fist but it is usually crushed, except at the beaks. The original of Billings's species came from Siluric rocks at L'Anse à la Vieille which is a shore bay fifty miles eastward of this point. With these Stricklandinias are Spirifers of the S. niagarensis type and occasional Whitfieldellas. The rest of the fauna throughout the beds is largely stromatoporoids and corals. These are in enormous quantity and very considerable variety. The Stromatoporas vary from the size of a penny to immense masses. There are Halysites of several species, Favosites and Alveolites of great size, two to three feet in diameter, Heliolites of compact and branching forms, Zaphrentis and other cyathophylloids of large size, Syringopora and Eridophyllum in extensive colonies and various species. These corals are commanding for their size and abundance and are in admirable preservation. The fauna is essentially a coral plantation, lacking the features, however, of true reef construction. Additional species observed are Calymmene, Chonetes, Atrypa reticularis, Tentaculites, Diaphorostoma etc.

From here the section continues on eastward to the Howatson property. Beginning with the cliff exposure at Howatson's the section must be studied at low tide on account of the narrow beach. Here again the heavy calcareous highly nodular beds occur, varying in color from dark green, gray, yellow to red. All are blocky and heavy bedded except for thin intervals of shale between the limestones. The small nodules of irregular size weather loose freely and scatter over the beach. While there is great variety of lithologic expression in these beds in this respect they do not differ essentially from the Pritchard section, but their fauna is more profuse though the preservation is inferior. Silicification is extensive and where decay has been effective beneath the soil on top of the cliff, silicified fossils are set free.



one. Black Cape,



Vertical cleft in the gray Siluric limestones filled with red Devonic or Bonaventure sandstone. Black Cape, Bay of Chaleur.

Stromatoporas, Heliolites and Favosites still abound; Cladopora and Trachypora are common, Camarotoechia like C. whitei and C. indianensis; Whitfieldella, Rafinesquina, Orthis, Atrypa reticularis (Niagara type), Calymmene, Orthoceras, Trochoceras etc. are present. About in the middle of this section occurs the infiltrated "vein" of red sandstone mentioned above, the surface of which can be traced in the fields overhead for two hundred feet away from the cliff.

From Howatson's the shore exposure continues without break into the Service and LeBlanc properties, the scraggy limestones maintaining their character as far as the little dock at Service's. Eastward from here follows a great thickness of gray sandstone, heavy bedded at first, thence passing upward into sandy shales. The sedimentation continues sandy to near the end of the section which terminates in the volcanic mass forming Black cape, but toward the top the sands become interlaminated with thin beds of volcanic ash, with red and purplish shale and eventually calcareous and variegated beds succeed, becoming in places compact limebanks entirely constituted of the debris of fossils. These abut against the volcanics of Black cape.

These sandstones and sandy shales are remarkably profuse in corals, some of the species, as of Halysites, palpably unlike those in the lower beds, but Halysites, Favosites, Heliolites, Syringopora and the stromatoporas of extraordinary variety and size occur together buried in this tremendous mass of sand. Plant remains, apparently fucoidal, are also present in the upper sands. The uppermost limestone banks are constituted of the debris of bryozoans and small corals which have been weathered out over extensive surfaces into exposures of much beauty and effectiveness; but other fossils than these are notably absent. The section on the whole is one well worthy of attention for its paleontology as well as its stratigraphy. The paleontologist would find at his hand unlimited quantity and variety of corals and stromatoporas, the museum collector fine demonstrative slabs and blocks and the stratigrapher a section of the Siluric apparently unexampled for its thickness and unusual composition. Leaving out of account repetitions of strata which thus far have not revealed themselves in structure or paleontology the entire section must approach a thickness of seven thousand feet. As far as the observed and collected fossils indicate the species are indirectly comparable to the later Niagaran of the interior basin, with an absence of the Clinton elements. The direct com-

parison in paleontology and paleogeography is doubtless to be made with the expressions of the Siluric afforded by the sections on Anticosti island and on the Arisaig shore of Nova Scotia. There is nothing in the Siluric sections of Gaspé elsewhere comparable to this, so far as my knowledge extends.

STRIKING UNCONFORMITY IN PALEOZOIC ROCKS AT LITTLE RIVER EAST, GASPÉ COUNTY

Little River East lies on the north shore of the Bay Chaleur just as it opens into the gulf. It is a small fishing hamlet about six miles west of Grand River. The unconformity here is of a sort that is general throughout the Gaspé peninsula where the upturned Siluric comes in direct contact with the Devono-Carbonic, but at this exposure it is so notable for its color contrasts as to attract attention of the traveler when steamer or sail happens to pass close enough inshore to bring it into clear view. The Little River is bounded on the west by a rock cliff reaching one hundred rods along the shore, and the base of the cliff is made up of light gray sharply stratified Siluric (Siluric-Ordovicic) thin limestones and hard shales standing at an almost vertical angle or dipping steeply toward the southwest: in this respect in conformity with the general attitude of the older paleozoics on all this coast. Over the very irregular edges of these lower beds lie the horizontal heavy-bedded masses of deep red Bonaventure conglomerate and sandstone, which has settled into all the surface irregularities of the gray Silurics. The section teaches again the well-known lesson of the exposure today of the Siluric rocks of this southerly Gaspé region during at least all the period of the early Devonic and its submergence in later Devonic to receive the rough water or continental deposits of the Bonaventure stage.

Little River East Gaspé — Unconformity between inclined Siluric strata and nearly horizontal Bonaventure conglomerate

NOTES ON DEVONIC FISHES FROM SCAUMENAC BAY, QUEBEC

BY L. HUSSAKOF

I An almost complete specimen of Coccosteus

Up to the present time Coccosteus has been known in America only from fragmentary remains. No specimen has been found showing the head with its associated armor plates, or with the notochord and dorsal fin. It is therefore of great interest to record the discovery recently of an almost complete specimen of Coccosteus canadensis — a species described by Dr A. S. Woodward,[1] in 1892, from a cranium. The specimen was collected for the New York State Museum, from the Upper Devonic shales on the shore of Scaumenac bay, near the village of Migouasha, Quebec. It came from a layer of thin-bedded shale at a level considerably below the massive, fine-grained sandstone containing the exquisitely preserved ferns made known by J. W. Dawson, and the splendid specimens of Bothriolepis with the soft structures and fins, described by Patten. The specimen was contained in a small slab of shale which had weathered out so that its upper surface lay exposed.

Description of specimen. The specimen consists of the head, a portion of the dorsal armor, several ventral plates, the impression of the notochordal region, some neural spines, and part of the dorsal fin. From its orientation on the slab, the animal appears to have become turned ventral side up after death, and to have settled into the sediment in that position. The head and dorsal armor were thus embedded in natural association, while the ventral plates, on the softer tissues loosening up, either had drifted out of their places (this is the case with the three plates seen in figure 1 to the right of the median axis of the specimen); or had fallen onto the dorso-median plate partly covering it. In collecting the fossil, the slab was unfortunately opened in such manner that most of the actual bone was lost and only the impressions (of the dorsal tuberculated surface) are shown in the rock.

Head. The head (CRAN) is 11½ centimeters long and shows, as impressions, most of the sutures and lateral lines. As it has already been well described by Woodward it is unnecessary to refer to it again in detail. To the left of the head is seen the right suborbital

[1] A. S. Woodward. Further Contributions to Knowledge of the Devonian Fish-fauna of Canada. Geol. Mag., N. S., Dec. 3, 1892, IX, p. 481–85, pl. xiii.

(SO). It is represented by actual bone, shown in outer, ornamented, aspect. The body of the plate is deeper, that is, more nearly circular in outline, than its homologue in C. decipiens.

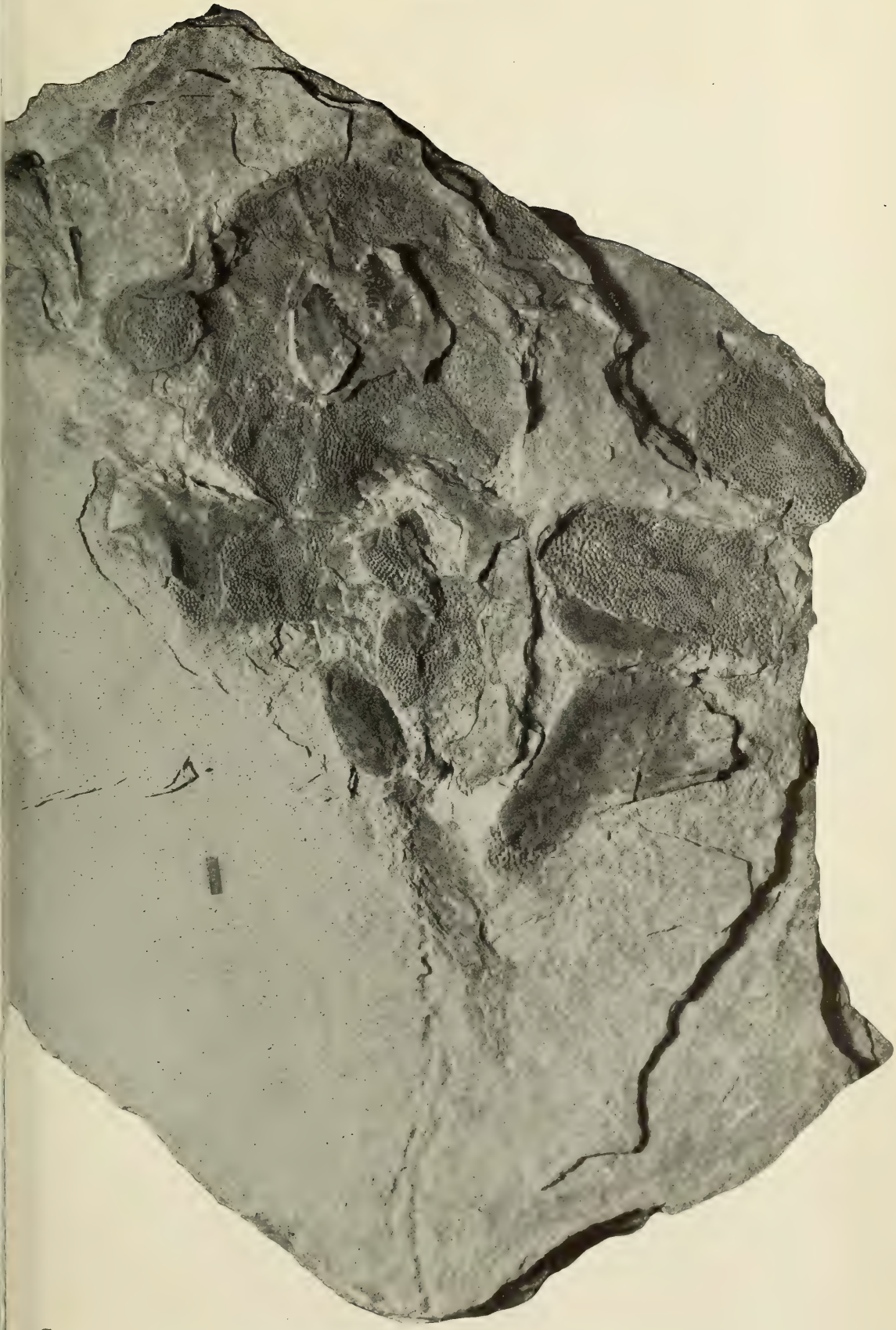
The present specimen throws light on one detail in the structure of the Arthrodire head. It is a moot question whether the so-called pineal canal, which is always seen on the inner aspect of the head of Arthrodira, perforated the bone and opened on the upper surface of the pineal plate. The state of preservation of the fossils has always left it open to doubt whether the pore on the upper surface had not been excavated by the collector while freeing the specimen from matrix. The present head of Coccosteus shows indubitably that the pineal canal did open on the upper surface of the head. For in the matrix, which is a cast of the upper surface, there is seen a small papilla (p) which is clearly due to the infiltration of sediment into the original opening on top of the head. The function of the canal is not known. But it may be inferred from its conical shape — seen especially in Dinichthys where, owing to its large size, it can be carefully studied — that it lodged a nerve organ which tapered to a point as it rose through the bone to the surface of the head. In the region of the external opening the surface of the cranium is either smooth, or tuberculated, like any other superficial bone, and not excavated for the reception of any sense organ, such as a pineal eye.

Mandibles. Portions of both mandibles (Mnd) are preserved. They show only the toothed portions of the elements, with small parts of the flattened posterior regions. There are seven teeth preserved in each mandible; they are like those in other Coccosteids — sharp, conical and slightly recurved.

Dorsal armor. The dorsomedian (DM) is 8½ centimeters long (excluding the process) and of the typical Coccosteid form. It exhibits the inner (under) surface and is largely covered over with fragments of other plates. I am not certain whether a posterior spine is present, since the hinder end of the plate does not show; but a keel is present, as is clearly indicated by the small part of it (k) preserved near the posterior end of the plate.

Only one antero-dorsolateral (ADL) is preserved, that of the right side. It retains its natural position with regard to the head and dorsomedian. Its lateral line is noteworthy since it consists of two branches which diverge at an acute angle a short distance back of the articulating process. A similar branched canal occurs on the anterior

Plate 1



Coccosteus canadensis Whiteaves. Scaumenac Bay, Quebec.

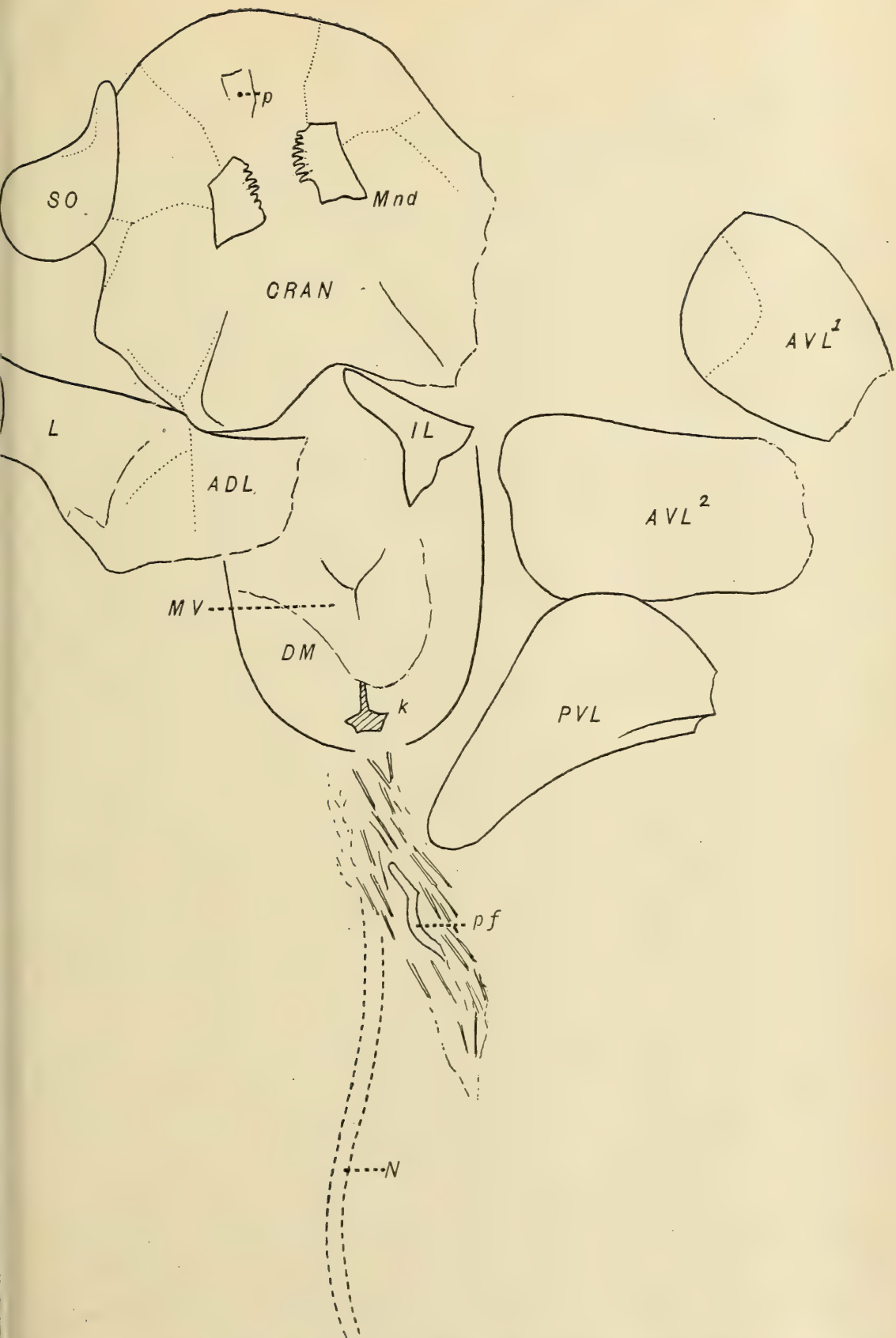


Fig. 1 Outline drawing of the specimen of Coccosteus canadensis Woodard, shown in plate 1. ADL, anterior dorsolateral; AVL¹, AVL², anterior ventrolaterals; CRAN, cranium; DM, dorsomedian; IL, inferolateral; k, "keel" of dorsomedian; L, lateral; Mnd, mandibles; MV, median ventral; N, impression of notochord; p, pineal opening; pf, "pelvic fin support"; PVL, posterior ventrolateral; SO, suborbital.

dorsolateral in some other coccosteids, for instance C. minor and C. magnus.

Neither of the posterior dorsolaterals is preserved.

Lateral plates. A lateral (L) and an interlateral (IL), both apparently belonging to the same side of the animal, are preserved. They are of the form usual in Coccosteids. They seem to be distinct plates and not, as might be expected by analogy with Dinichthys, the halves of a single plate.[1]

Ventral armor. The ventral plates are shifted from their natural positions and incompletely preserved. The antero-ventrolateral (AVL[1]) of the left side is preserved in outer aspect. It is relatively broad and characterized by the presence of a lateral line on its anterior third. The ornamentation on this plate is well preserved; it consists of small, blunt, conical tubercles with fine radiations at their bases.

The right postero-ventrolateral (PVL) is seen from the inner side; it is of the form usual in Coccosteus.

The median ventral (MV) is only partly preserved — in outer ornamented aspect. Its over-lapped flanges seem broader than common in Coccosteus — probably an adaptation for strengthening the ventral armor.

Notochordal region. This is shown here for the first time in an American coccosteid. Immediately behind the dorsomedian plate there is a group of neural spines and dorsal fin-rays, represented by their actual tissue. Back of these, extending a distance of 13 centimeters, to the end of the slab, there is a double series of impressions arranged in a gently sigmoid line. These correspond to neural and hemal arches and indicate the position of the notochord (N). Impressions of some neural spines are also clearly shown.

About 4 centimeters back of the dorsomedian there is a sickle-shaped rod (p.f) terminating posteriorly in what seems to be a broad plate, though this is either buried in the matrix or missing. This element I identify as one of the so-called "pelvic fin" supports, recently discussed in detail by Professor Dean.[2]

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[1] A discussion of these elements has recently been given by Burnett Smith. Notes on Some Little-known Fishes from the New York Devonian. Proc. Acad. Nat. Sciences Phila., Dec. 1910, p. 656–63.

[2] Bashford Dean. Studies on Fossil Fishes (Sharks, Chimœroids, and Arthrodires). Mem. Amer. Mus. Nat. Hist., IX, 1909, p. 282.

GENERAL CONCLUSIONS

Coccosteus canadensis is one of the largest species of the genus. It is distinguished from the best known species, C. decipiens of the Old Red Sandstone of Scotland, first, by its larger size, and second, by trivial differences in the shapes of several of its plates. It is quite close to Dinichthys halmodeus (Clarke) of the Marcellus shales of New York. Indeed the latter is very probably to be put back into the genus Coccosteus, in which Doctor Clarke had originally placed it;[1] for its supposed dinichthyid characters listed by Doctor Eastman,[2] when judged by our present knowledge of Coccosteus, are hardly enough to take it out of that genus. The mandibles, upon which Doctor Eastman chiefly based his opinion, seem to me typically coccosteid though poorly preserved. Moreover Dr Burnett Smith has recently shown[3] that in this species the laterals and interlaterals of each side are separate elements, as in Coccosteus, and not a single plate as in Dinichthys. From these facts it appears that Coccosteus halmodeus — not Dinichthys halmodeus — is the correct name of the Marcellus species.

The coccosteids hitherto recorded from North America are therefore the following:

1 Coccosteus occidentalis Newberry
2 " canadensis Woodward
3 " halmodeus Clarke
4 " macromus Cope
5 " cuyahogae Claypole
6 " (Protitanichthys) fossatus (Eastman)

Of these six C. canadensis is the one now represented by the best material.

II Note on a remarkable specimen of Eusthenopteron foordi

A remarkable specimen of Eusthenopteron foordi has lately been collected by Doctor Clarke in the type locality, Migouasha P. Q., Canada, and is preserved in the New York State Museum.

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[1] John M. Clarke. New or Rare Species of Fossils from the Horizon of the Livonia Salt Shaft. Thirteenth Ann. Rept. State Geologist, N.Y., 1893, p. 161–80, pl. i-iv.

[2] Devonic Fishes of the New York Formations. N.Y. State Mus. Memoir 10, 1907, p. 126. The synonomy of the species is given there also.

[3] Notes on Some Little-known Fishes from the New York Devonian. Proc. Acad. Nat. Sci. Phila., 1910, p. 661.

It represents a very large fish, perhaps the largest Eusthenopteron ever found, measuring nearly three feet in length, and at the same time shows nearly all the anatomical structures thus far made out in this species.

The accompanying figure gives a good idea of the specimen. The fish is seen from the left side, and is so oriented that the paired fins of both right and left sides are shown, while the caudal end is seen in profile. An important fact to be deduced from the appearance of the fossil is that Eusthenopteron was a more slender fish than the current textbook restoration, which we owe to Whiteaves, makes it appear. The depth of the fish in the region of the ventral fins can be accurately measured in the specimen; it is found to go over seven times into the total length (including tail). Hence the *maximum* depth of the fish must have been contained six or six and one-half times in the total length, not four and two-thirds as in Whiteaves's restoration. In other words, Eusthenopteron was shaped a good deal like Tristichopterus, its nearest allied form.

In the head region most of the cranial elements can be plainly made out. The opercular elements are separated from the shoulder girdle by a wide space, part of which no doubt represents the soft membrane back of the operculum. The operculum (Op) and the subopercul um (S. Op) are clearly shown. The large plate, P. Op, probably comprises, as remarked by Traquair,[1] both a preoperculum and one or more cheek-plates; but the sutures separating these parts can not be clearly made out. The cleithrum (Cl) is broken off at its lower end; the piece I. Cl, is probably the infra-clavicle broken away from the cleithrum and shifted from its position. A gular plate (G), that of the left side, is beautifully preserved. There is no indication of lateral gulars in this specimen; but it should be recalled in this connection that Traquair found in a specimen in the Edinburgh Museum "the presence of five narrow lateral jugulars [i. e. gulars] very distinctly shown." The mandible (Mnd) apparently has sutures separating the dentary from one or more infradentaries, but they can not be plainly made out.

The fins are all present and are remarkable for the preservation of their internal cartilaginous supports. Those of the pectorals agree with the figure of these elements given by Woodward.[2] The ventral supports are not so well preserved; one can make out, how-

[1] Traquair, R. H. Notes on the Devonian Fishes of Scaumenac Bay and Campbelltown in Canada. Geol. Mag., Decade 3, VII, 1890, p. 15–22.

[2] Woodward, A. S. Outlines of Vertebrate Palaeontology. 1898, figure 23.

Fig. 2

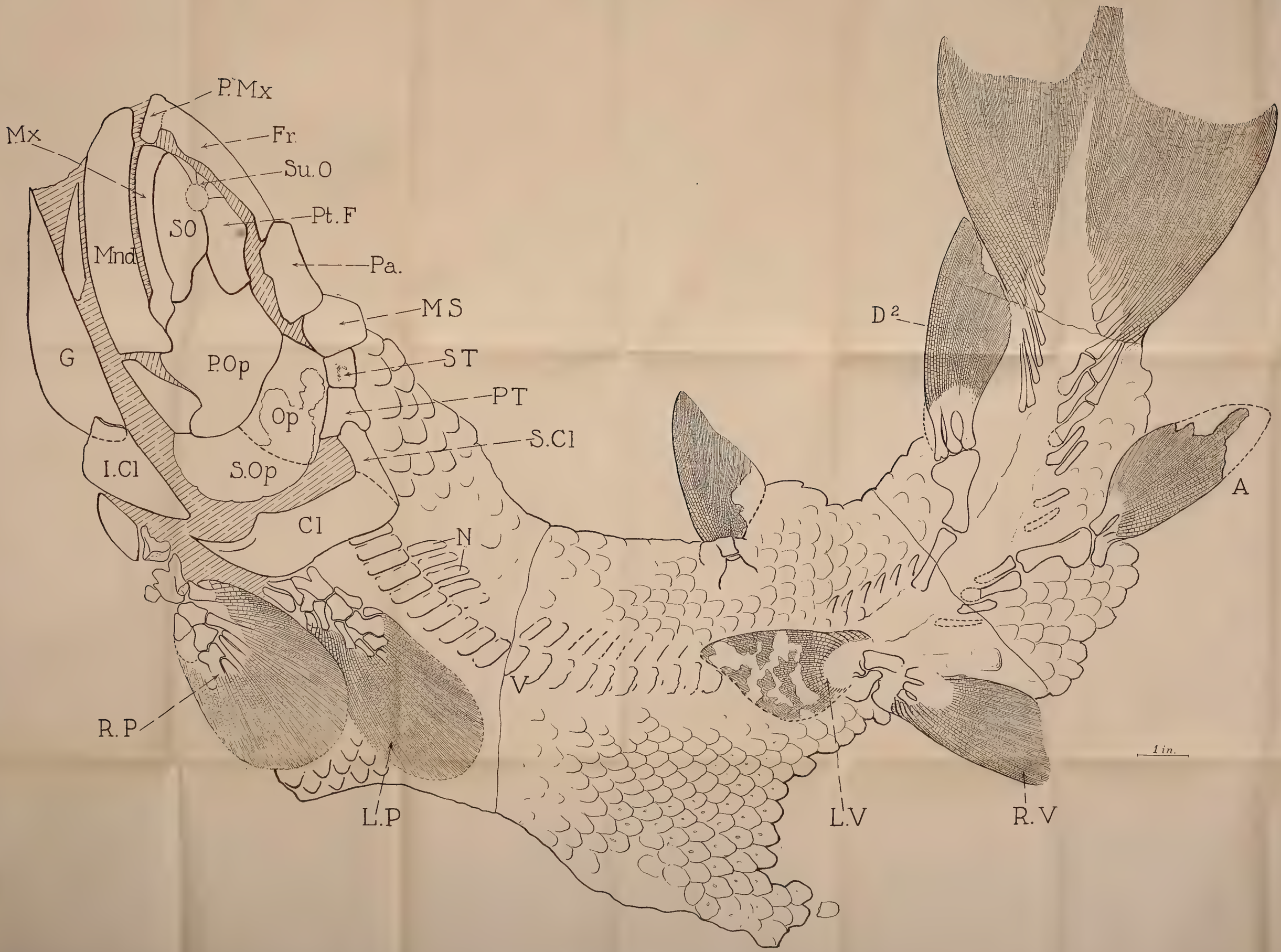

Figure 2 EUSTHENOPTERON FOORDI. Whiteaves. x....
Scaumenac Bay, Quebec. Specimen in New York State Museum

A, anal fin; Cl, cleithrum; D^1, D^2, dorsal fins; (D^2, accidentally omitted in lettering, should indicate the fin in front of D^2) Fr, frontal; G, gular plate; I. Cl, infraclavicle; L. P, left pectoral; L. V, left ventral; Mnd, mandible; MS, median supratemporal; Mx, maxilla; N, neural spines; Op, operculum; Pa, parietal; P. Mx, premaxilla; P. Op, preopercului; PT, posttemporal; Pt F, postfrontal; R P, right pectoral, R V, right ventral; S. Cl, supraclavicle; SO, suborbital; S. Op, subopercului; ST, lateral supratemporal; Su. O, supraorbitals; V, vertebral centra

xM

ever, at the base of the fin, three small elements, parallel to one another, which are articulated proximally with one or two elements that can not be clearly made out on account of their crushed condition. These two rows of cartilaginous elements correspond respectively with the a-2 and a-3 series of the pelvic fin figured by Goodrich.[1]

Regarding the supports of the unpaired fins, those of the second dorsal (D^2) and of the anal (A) are beautifully shown. Their number, form and arrangement are already well known from Whiteaves's restoration. They are almost exact counterparts of each other. One point worth noting is that in the anal there seem to be only two instead of the three separate basilar rods found in the dorsal. The internal supports of the first dorsal (D^1) are also to some extent shown, although one can not make out the separate parts beyond what they are shown in the figure.

A feature of great interest in the specimen is the clearness with which the vertebral centra (V) are shown in the front half of the fish. The presence of vertebrae in Eusthenopteron has already been recorded by Traquair.[2] They extend only as far back as the first dorsal, behind which the notochord was apparently continuous, although neural and haemal spines were well developed. Twenty centra can be counted between the cleithrum (Cl) and the first dorsal fin. They are seen in profile so that one can not be certain whether they are complete rings or not. Each is about two and one-half times as high as wide, and provided with a neural spine. The haemal spines, if present in this region, are not shown. The centra are separated from one another by narrow spaces which increase backward until, near the end of the series, they are equal to the width of the vertebrae.

MEASUREMENTS OF THE SPECIMEN

Total length	2 feet	10 inches
Total length, allowing for missing tip of the tail	2 "	11 "
Head (to end of operculum)		7⅞ "
Depth across head (1 inch back of eye)		3¾ "
Depth in region of D^1		4¾ "
Depth between D^2 and anal		4 "
Gular plate, length (slightly restored)		5⅛ "
Gular plate, greatest width		1⅝ "
Greatest height of caudal fin		6¾ "

[1] Goodrich, E. S. On the Pelvic Girdle and Fin of *Eusthenopteron*. Quart. Jour. Microscop. Sci., N. S., XLV, p. 311–24, pl. xvi.

[2] Op. cit. p. 17.

III Notes on the anatomy of Scaumenacia curta

The New York State Musuem possesses a series of fourteen specimens of Scaumencia curta (Whiteaves), one of them more perfect than any other yet found, and the rest with one or another feature well preserved. Through the kindness of the Director of the Museum, this collection was recently placed in my hands for study. I have taken this ocasion also to go over the excellent materials, comprising some fifteen specimens, in the American Museum collection, and have also examined one fine, large specimen belonging to the Yale Museum.[1] These thirty odd specimens make up the largest assemblage of Scaumenacia ever brought together at one time, and afford excellent data for a reconstruction of the fish and for elucidating a number of anatomical details still imperfectly known. The specimens are all from the type locality — the Upper Devonic shales on Scaumenac bay, Quebec. A few are from the massive fine-grained sandstone in which the soft structures of Bothriolepis occur; the rest are from thin-bedded shales at a level considerably below this horizon.

Scaumenacia was first described by Whiteaves in 1881 [8]. He regarded it as belonging to the genus Phaneropleuron, and named it P. curtum. In 1887 [9] he discussed the anatomy of this fish and figured one of the types and several anatomical details — cranial plates, dentition and scales. These confirmed him in his original opinion that the fish was a dipnoan. In 1889 [10] he published a "slightly restored" figure of the fish.

In 1893 Traquair [7] pointed out that this fish differed from Phaneropleuron in having two dorsals instead of one. He therefore regarded it as a distinct genus for which he proposed the name Scaumenacia.

Two restorations of Scaumenacia have been published, one by Whiteaves (mentioned above), the other by Traquair, in Dollo's paper "Sur la Phylogénie des Dipneustes" [1]. Several anatomical features, in addition to those by Whiteaves mentioned above, have also been figured: a dental plate (Jaekel [4]); the head (Eastman [2]); and the anal fin (Woodward [11]).

Size. Most of the specimens of Scaumenacia are small, under 10 inches in length, giving the impression of a rather small fish.

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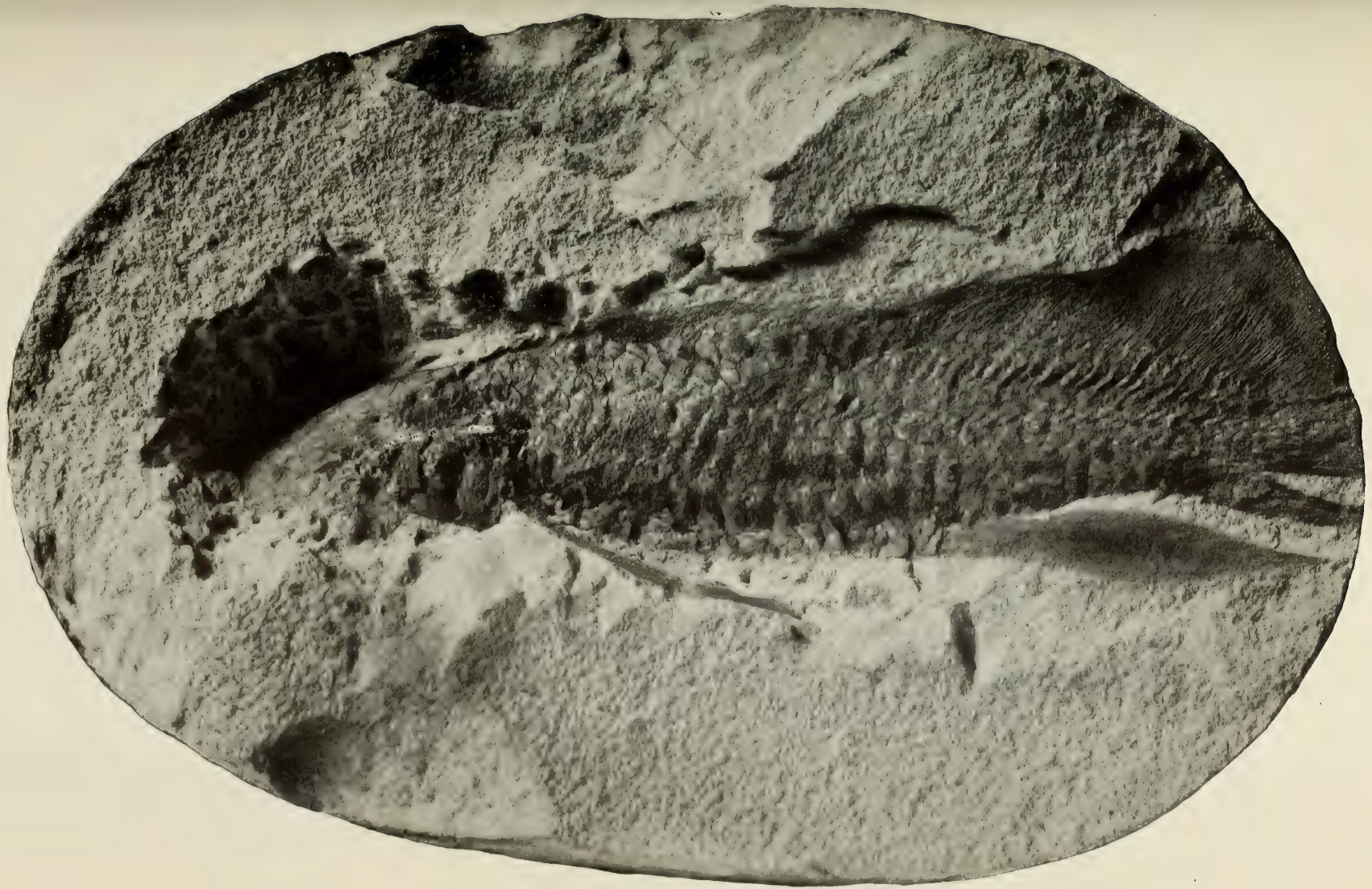
[1] This specimen was kindly lent me for study by Professor R. S. Lull.



Scaumenacia curta (Whiteaves). Upper Devonic, Scaumenac Bay, Quebec.

Remains of larger fish are, however, known. A specimen in the American Museum lacking part of the tail measures 14½ inches, and when complete must have been 18 inches in length. Another large fish, no. 2875 Yale Museum, is about 15 inches long. Hence Scaumenacia may be regarded as having reached a length of at least 18 inches; in other words to have been as large, full grown, as a medium sized Neoceratodus.

Restoration. The accompanying restoration (figure 3) is based on a beautiful specimen in the New York State Museum. This is a fish eight inches long in a nodule of fine-grained sandstone (plate 2). It is almost uncrushed, which is an important circumstance, for Scaumenacia specimens are usually badly distorted through lateral pressure so that the fish appears much deeper than it must have been in life. This specimen shows all the fins save the caudal, which is nearly all missing. But this fin, fortunately, is beautifully preserved in another specimen of the same size (7661 American Museum). The State Museum specimen also shows the scales so that their size and imbrication can be clearly seen on the greater part of the fish.

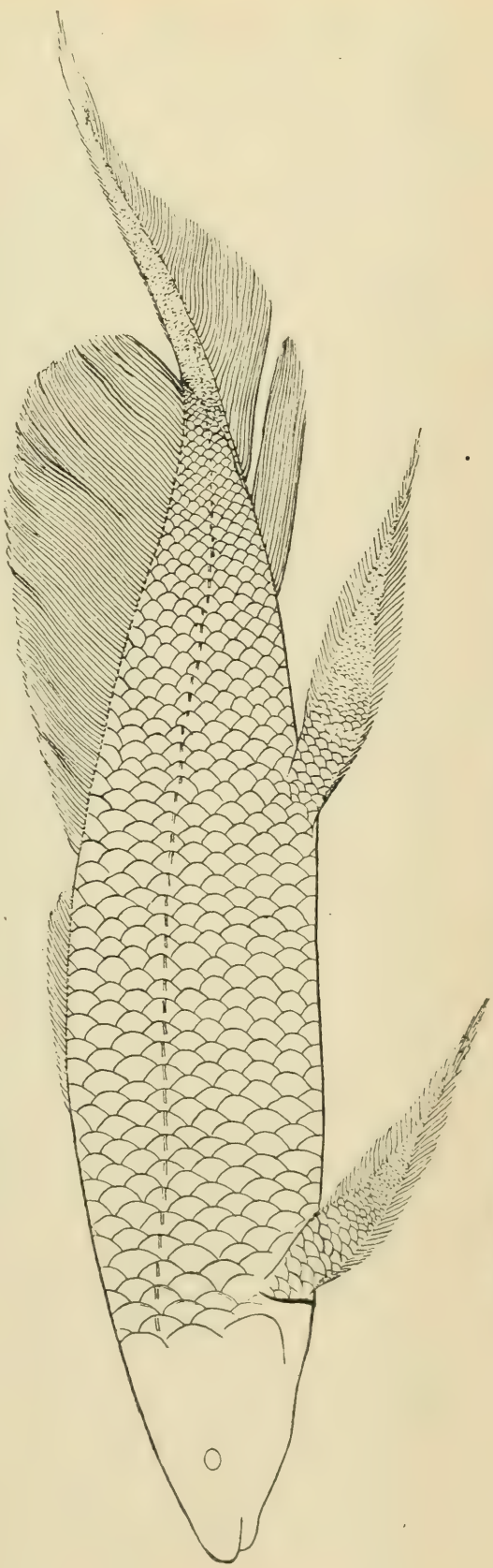


Fig. 3 Restoration of Scaumenacia curta (Whiteaves). Upper Devonic. Scaumenac bay, Quebec, Can.

The distinctive features of Scaumenacia may be summarized as follows:

Body-form gracefully fusiform, about as much compressed as Neoceratodus. Maximum depth equal to head, and contained six times in total length (including caudal). Fins well developed; paired fins archipterygia, large and relatively slender, with scaled central portion and divergent marginal dermal rays. Length of pectoral one and one-third times the maximum depth of body; when adpressed to body extending over two-thirds the distance from origin of pectoral to origin of ventral. Ventral longer and somewhat broader than pectoral, about one and one-half times the maximum depth of body; commencing slightly back of origin of second dorsal. First dorsal very low, its maximum height one-seventh or one-eighth its length; commencing considerably back of occiput, but somewhat nearer to origin of pectoral than that of ventral. Space between dorsals one-seventh the length of first dorsal. Second dorsal very much higher than first, its maximum height two-thirds the maximum depth of fish. Caudal strongly heterocercal. Anal relatively small, situated close to lower lobe of caudal. Lateral line present.

Cranium. Three specimens (2875 Yale Museum; 7656 and 7677 American Museum) in the materials in hand, show the cranium in fair preservation. Figure 4 is based on these, more especially on the Yale specimen. The arrangement of the cranial elements is quite like that in Phaneropleuron as figured by Goodrich [3, p. 239]. There is a median supra-temporal (MS), preceded by a pair of parietals (Pa), and anterior to these a pair of frontals (Fr). The suture between the frontals is rather vague in the Yale specimen, but it is very clearly shown in an American Museum specimen (7677). There are also a number of other paired plates arranged symmetrically on either side — pterotics (Pter), supraorbitals (Su. O), and several others whose homology is not quite clear. The rostral region is lacking in all the specimens in hand and is indicated in the figure by analogy with other dipterine crania.

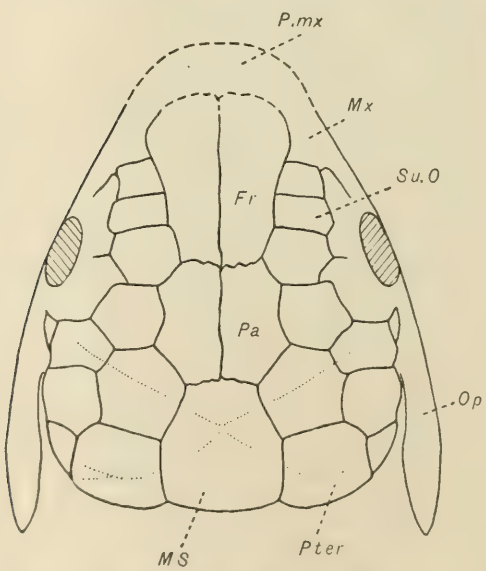


Fig. 4 Head of Scaumenacia curta (Whiteaves). Fr, frontal; MS, median occipital; Mx, maxilla; Op, operculum; Pa, parietal; P. mx, premaxilla; Pter, pterotic; Su. O, supraorbitals.

Scaumenacia curta (Whiteaves). Nearly complete fish showing especially well the caudal half — Upper Devonic, Scaumenac Bay, Quebec.

Dentition. It is well established that Scaumenacia had typical dipnoan dental plates. Whiteaves [9] figured a portion of such a plate showing a group of pointed denticles arranged in rows; and Jaekel [4] has given a figure of a complete lower dental plate.

Figure 5-b represents an upper, or palato-pterygoid, dental plate drawn from a small specimen in the American Museum collection (7662). This plate and the one figured by Jaekel show plainly that Scaumenacia had a Dipterus-like dentition. The dental plate shows seven rows of small pointed and slightly compressed denticles. The rows do not radiate from a common point but from a smooth area near the inner angle of the tooth. The number of denticles in a row varies from two or three in the innermost, to seven or eight in the outermost row.

Fig. 5 Scaumenacia curta (Whiteaves); dental plates and scale. *a*, vomerine teeth; *b*, palato-pterygoid dental plate; *c*, portion of a scale, showing ornamentation (enlarged)

Besides a dipterine plate I have found vomerine teeth in Scaumenacia (figure 5-a). These are of great importance considering the rarity of specimens of these teeth in the extinct dipnoans. They were found in their natural position in a large fish in the American Museum (no. 7656). When collecting the specimen in the field it was accidentally struck so that the snout broke off as a small fragment. On the inner surface of this, and right in advance of the most anterior denticles of the upper and lower dental plates, could be seen, above, a pair of small, thin vomerine plates (figure 5-a). They are broader than deep, with the lower edge cut into four unequal, sharp teeth or serrations. In view of this serrated condition the vomerines of Scaumenacia may be regarded as more primitive than those of the adult Neoceratodus. They resemble somewhat the vomerines of the embryonic Neoceratodus as described by Semon [5]. The small fragment of matrix containing these teeth was unfortunately lost; not, however, before a careful figure of the vomerines had been prepared.

Scales and lateral line. Regarding the scales, Whiteaves wrote [9, p. 108]: "Scales thin, cycloid, imbricating with exposed surfaces concentrically striated and marked also with exceedingly minute radiating lines, which latter are only visible under a somewhat powerful lens." The superficial ornament of the scales is indeed

exceedingly fine. It is very generally worn off so that it is hard to find a specimen showing it. On several scales in the specimen belonging to the Yale Museum (2875) it is well shown and from one of these figure 5-c was drawn. The ornament consists of exceedingly fine lines, several of which may flow together towards the center of the scale into an elongate irregular elevation. From this area the lines are given off at irregular intervals and may again fuse here and there for part of their length. They may be traced to the posterior border of the scale.

The lateral line Scaumenacia has not yet been figured, although it is known to be present in this form. It is here figured in a small specimen three and one-quarter inches long, in the New York State Museum, in which it is beautifully preserved.

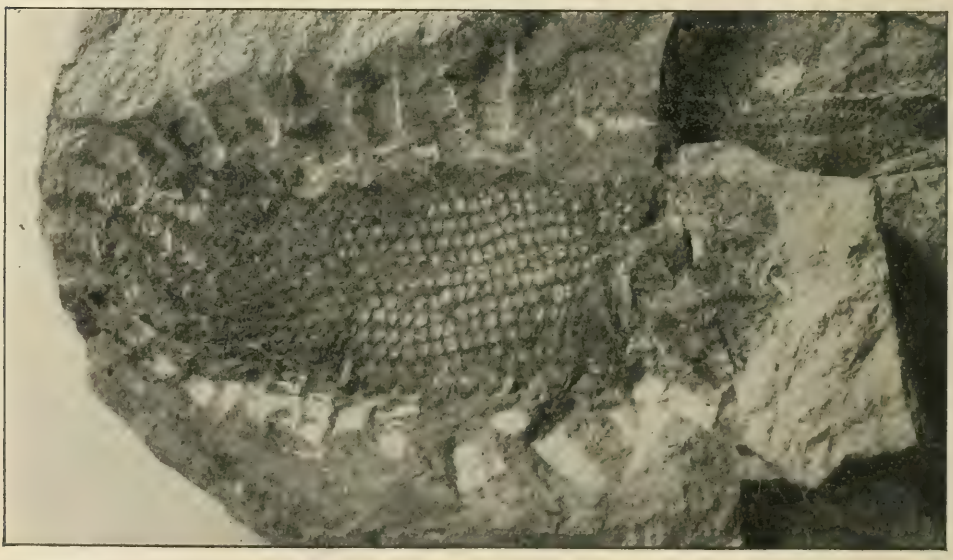


Fig. 6 Scaumenacia curta (Whiteaves). Small specimen, 3¼ inches in length, showing ateral line; natural size. Upper Devonic. Scaumenac bay, Quebec, Can.

LITERATURE CITED

1 **Dollo, Louis.** 1895. Sur la phylogénie des dipneustes. Bull. Soc. Belge de Géol., IX, p. 79–128, pls. v-x. [Pl. v, fig. 6, is an outline restoration of *Scaumenacia curta,* labeled "Figure original de M. R. H. Traquair."]

2 **Eastman, C. R.** 1908. Devonian fishes of Iowa. Am. Rep't Iowa Geol Surv. XVIII. [Figure of head of Scaumenacia. Fig. 35.]

3 **Goodrich, E. S.** 1909. Vertebrata craniata (First fascicle: Cyclostomes and Fishes). Lankester's "A treatise on zoology." Part IX.

4 **Jaekel, O.** 1890. [On *Phaneropleuron* and *Hemictenodus,* n. gen.] Sitzber. Gesell. naturforsch. Freunde Berlin. p. (1–8).

5 **Semon, R.** 1899. Die Zahnentwickelung des *Ceratodus forsteri.* Zool. Forsch. in Austral. u. Malay Archipel: p. 115–35, pls. xviii–xx.

6 **Traquair, R. H.** 1890. Notes on the Devonian fishes of Scaumenac Bay and Campbelltown in Canada. Geol. Mag., n. s., Dec. iii, VII, p. 15–22.

7 ————————. 1893. Do. No. 3. Geol. Mag., n. s., Dec. iii, X, p. 262–67.

8 **Whiteaves, J. F.** 1881. On some remarkable fossil fishes from the Devonian rocks of Scaumenac Bay, P. Q., with descriptions of a new genus and three new species. Canadian Naturalist, n. s., X, p. 27–35.

9 ————————. 1887. Illustrations of the fossil fishes of the Devonian rocks of Canada. Part I, Trans. Royal Soc. Canada, IV, p. 101–10, pl. vi-x.

10 ————————. 1889. Do. Part II. Trans. Royal Soc. Canada, VI, p. 77–96, pl. v-x.

11 **Woodward, A. S.** 1893. Note on a case of subdivision of the median fin in a dipnoan fish. Annals and Mag. Nat. Hist., ser. 6, XI, p. 241–42, figure

NOTE ON A SPECIMEN OF PLECTOCERAS JASON (BILLINGS)

(With one plate)

BY RUDOLF RUEDEMANN

Preparations for the moving of the State Museum to the new Education Building brought to light a block of middle Chazy limestone from Valcour, Clinton county, N. Y., collected by Professor van Ingen and the writer, which had not been at hand when the Cephalopoda of the Beekmantown and Chazy formations of the Champlain Basin were described by the writer (N. Y. State Mus. Bull. 90, 1906), but which is so much superior in perfection of shell and in size to the specimens used for that paper that we are sure the publication of its figure will be an addition to our knowledge of the form. Above all it shows the entire living chamber and the apertural margin, both not observed before, as far as we are aware.

The living chamber attains in length a little more than one-third of a volution. It is entirely free and furnished in the specimen with very strong costae except near the aperture where the ribs cease rather abruptly. The aperture is directed as it had been described from the growth lines in the above-mentioned paper.

We have drawn in the nepionic and neanic portions observed in another specimen and figured in longitudinal section in the former publication,[1] thus obtaining a view of the entire specimen. The rate of growth of the conch is thereby distinctly shown.

The uncoiled condition of the entire living chamber and the disappearance of the ribs near the aperture suggest that the specimen had attained mature if not gerontic age, and the shell therefore represents the full size of this species.

The septate portion of the whorl here represented is exfoliated and therefore, while showing the septa, fails to show the costae which are much closer in the neanic shell. The surface of this portion is represented in Bulletin 90, plate 29, and indicated in the restored part. The living chamber is also largely exfoliated and only shown in its interior cast and the smoother character of the apertural portion may be largely due to this state of preservation. The last portion of the apertural chamber would then seem to have possessed a thicker wall. On account of the absence of the shell, the conch now also appears more evolute than it was in reality.

[1] Text figure 44, page 485. The figure is in natural size, and not X ¾ as erroneously marked.

The depth of the cameras increases but little in the specimen and they remain relatively shallow as they had been found to be in the smaller specimens; the lateral lobe of the later sutures is apparently a little higher than in the earlier ones.

The species was cited in Bulletin 90 as coming from the lower Chazy of the Valcour section. The specimens described had been obtained by Professor van Ingen and the writer in the beds outcropping along the shore of Lake Champlain north of Valcour (Sibley's) dock. These beds were in preceding publications referred to the lower Chazy on lithologic grounds but fossil lists since published by P. E. Raymond (Annals of the Carnegie Mus., vol. 3, No. 4) show that they belong with the middle Chazy (see op. cit. p. 574). Doctor Raymond cites P. jason from B120 (op. cit. p. 535), i. e. the beds just across the bay north of Sibley's dock; B124, the rocks at lake level on the shore at Day's Point; and his station B128, exposures in the large quarries near the road between Valcour and Day's Point. Our records show the species to have been found in beds approximately corresponding to Raymond's stations between these two points. In all the stations where it has been found it is associated with faunas which, although lacking the Maclurites magnus, are of middle Chazy aspect, the beds in the quarries representing Raymond's zone 2a or the Malocystites murchisoni zone of his division 2 (middle Chazy). If Plectoceras jason is here a middle and possibly upper Chazy form, its range agrees with that observed in its type locality, the Mingan islands.

Plectoceras jason (Billings). Natural size
Chazy limestone, Valcour, N. Y.

ON THE GENESIS OF THE PYRITE DEPOSITS OF ST LAWRENCE COUNTY

BY C. H. SMYTH, JR

In an effort to get some clue to the methods of formation of the pyrite deposits of St Lawrence county, which in recent years have been more extensively worked than before, the important mines and several pits and prospects were visited and examined with such care as limited time and the conditions of the workings permitted. The expectation, based upon previous knowledge of the geology of the region, that the problem would prove a troublesome one to solve was fully justified by the result. A thoroughly satisfactory investigation of the matter can be carried through only after the general geology of the region is worked out in detail, but as this consummation is doubtless remote, a statement of the results of the present study seems warranted.

The most important workings are the mine on the Cole farm, four miles northeast of Gouverneur, the Stella mines, one mile north of Hermon, and the group of mines at Pyrites, or High Falls, on the Grasse river, six miles south of Canton. Besides these there are many smaller mines and prospects scattered over this part of the county and, as the geological conditions which favor the formation of the pyrite deposits prevail over a large area, it is probable that many occurrences have escaped notice.

GENERAL GEOLOGY

The geology of the region is exceedingly complex and, for the most part, as yet unstudied in detail; but, speaking in most general terms, there is an older series of highly metamorphosed sediments, crystalline limestones, gneisses, schists and quartzites, classed as Grenville, cut by igneous rocks of varying character and age, but chiefly granites, which are generally gneissoid. More basic rocks, diorites and gabbros, are not lacking but, particularly as regards the latter, are much less important than farther south, in the heart of the Adirondack region.

The typical rocks of either class, sedimentary or igneous, are of course readily distinguished, but in many cases extreme metamorphism has completely obscured the original character, making a positive determination difficult or even impossible. It often happens, too, that a rock is of composite character as a result of injection or assimilation, giving, on the one hand, a sediment more or less

"soaked" with igneous material and on the other an igneous rock which has melted into itself or assimilated sedimentary material. Between these two types every gradation exists, thus introducing added complication and uncertainty.

The pyrite deposits occur in association with the sedimentary rocks, although it is probable that they are more or less closely dependent upon the igneous rocks for their existence.

Throughout the Grenville series pyrite is a rather common accessory mineral and becomes particularly conspicuous in the so-called "rusty gneisses" which frequently occur. These rusty gneisses owe their name to the dark iron stain resulting from the weathering of pyrite, which is often present in large amounts. The question of the true nature and origin of the rusty gneisses is most intimately connected with that of the pyrite deposits, which in many, if not all, cases are merely exceptionally pyritiferous varieties of these rocks, or of rocks closely associated with them. At the very outset this makes the problem in hand difficult, since it necessitates the determination of the character of a widespread group of rocks which, though superficially similar, vary in character rather widely and may be of quite diverse origin in different cases.

In dealing with the Grenville one is on safe ground in classing the crystalline limestones and quartzites as metamorphosed sediments, but with reference to the schists and gneisses the case is quite different. While many of these may with confidence be regarded as metamorphosed shales or impure sandstones and limestones, others are beyond question intrusive sheets and dikes, while it is possible that some may originally have been contemporaneous lava flows and tuffs, though no case of the latter kind has yet been established. Thus while the rusty gneisses appear as part of the Grenville series, it does not necessarily follow that they are of sedimentary origin, though it has become rather habitual to take this view of them. That this course is in general justified seems probable from the fact that these rocks are strongly banded, exceedingly variable in composition, and so far as studied not closely related in composition to any of the well-established types of igneous rocks. It must be admitted, however, that some examples, marked by the presence of scapolite replacing plagioclase, closely resemble certain varieties of gabbro.[1]

If all of these pyritiferous rocks could be regarded as representing metamorphosed gabbros, a simple solution of the whole problem

[1] Smyth, C. H. jr, Trans. N.Y. Acad. Sci., XII, 1893, p. 215–17.

would be suggested, the pyrite being a probable primary constituent, concentrated by magmatic differentiation. As shown below, this explanation is, at first glance, strongly suggested for one of the chief deposits but further study indicates that it is inapplicable even here, while as a general explanation of the rusty gneisses it has no claim to consideration.

For the present it may be assumed that the rusty gneisses are of sedimentary origin, representing shales and sandstones interbedded with the limestones of the Grenville sea.

With this brief introduction, the different mining localities may be described, taking them in order from west to east, and in each case first stating the facts observed in the field and then giving the leading megascopic and microscopic features of typical specimens of ores and wall rock. The paper closes with a general discussion of the problem of genesis.

THE COLE MINE

The Cole mine, situated about four miles north of Gouverneur, was idle when visited by the writer, but has since been started up again and is likely to be an important producer. Rock exposures around the flooded pit were not extensive but sufficient to show the usual strongly foliated rusty gneisses, the more pyritiferous parts of which constitute the ore. Beneath this is a mica schist, and still lower down, with a gap of five or six hundred feet in outcrops, is a beautiful serpentinous limestone. Thus the rocks are distinctively Grenville in type and, as a matter of fact, the location is in the midst of one of the most extensive of the Grenville limestone belts of the region. The only recognizable igneous rock associated with the ore is pegmatite which occurs in small patches and strings, particularly in the underlying mica schist. All of the rocks present, including the pegmatite, contain some pyrite, and here as elsewhere the ore body is merely that part of the gneiss and schist formation in which the amount of pyrite is particularly large.

The pyrite is very irregularly distributed, appearing in streaks, bunches and veins (figure 1).[1] As the mineral increases in amount these irregular masses blend and form large and rich ore bodies, in which the relation of the pyrite to the rock is wholly obscured. But in the leaner ore the pyrite appears distinctly, so far as its present distribution is concerned, to be of vein origin for, while commonly running parallel to the banding of the rocks, it

[1] For all the photographs in this paper the writer is indebted to the kindness and skill of Professor Gilbert van Ingen.

repeatedly cuts across at all angles and wanders about quite independently. Thus it is evident that at least a part of the pyrite has been deposited in its present position quite late in the history of the formation. The pyrite ranges from tiny scattered grains up to large masses, and may be irregular in shape or bounded by its own crystal faces. Crystals an inch or more in diameter are common, not in cavities but wholly imbedded in the country rock.

Intimately associated with the pyrite is graphite in sufficient abundance to be conspicuous in the tailings from the separator.

While the gangue is ordinarily the normal country rocks, the dump affords many lumps of quartz whose relations to the ore and other rocks are not shown in the flooded pit. This material appears to be vein quartz, in spite of its carrying considerable graphite.

The ore body is perhaps ten feet thick as an average and conforms in a general way with the strike and dip of the surrounding rocks. That the latter are, with the exception of the pegmatite before mentioned, apparently sedimentary in origin is the most striking fact exhibited at this locality with reference to the origin of the pyrite deposits in general.

While the sedimentary character of the immediately adjacent rocks is apparent, it must not be overlooked that everywhere the Grenville is cut by intrusives which, in this vicinity, are abundantly represented by the white granite which is the common phase of the granite-gneiss when intrusive in limestone. With these intrusions, the pegmatite associated with the pyrite must be connected, and quite possibly too the quartz mentioned above, in spite of its graphite, the latter mineral being frequent and sometimes abundant in very acid pegmatites elsewhere associated with pyrite. A quarter of a mile south of the mine the crystalline limestone contains large quantities of quartz, probably of vein origin, but quite free from both pyrite and graphite.

Passing to the more detailed features of the deposits we find a fine-grained, gray banded schist of the wall containing considerable scattered pyrite strung out parallel to the foliation, while a minor cross fracture is filled with calcite and a little pyrite, the latter permeating the wall of the fissure and thus showing a very late circulation of pyrite in the rock. A thin section shows abundant quartz, kaolinized feldspar, chloritized mica, some sericite and graphite. There are also many grains of colorless tourmalin. Pyrite, in moderate amount, occurs in crystals and rodlike and branched aggregates, which run between and very commonly project into the other minerals as shown in figure 3. Sometimes pyrite separates and

Fig. 1 Lean ore, Cole mine, showing large, irregular masses of pyrite in the fine-grained rock. (9/10 natural size)

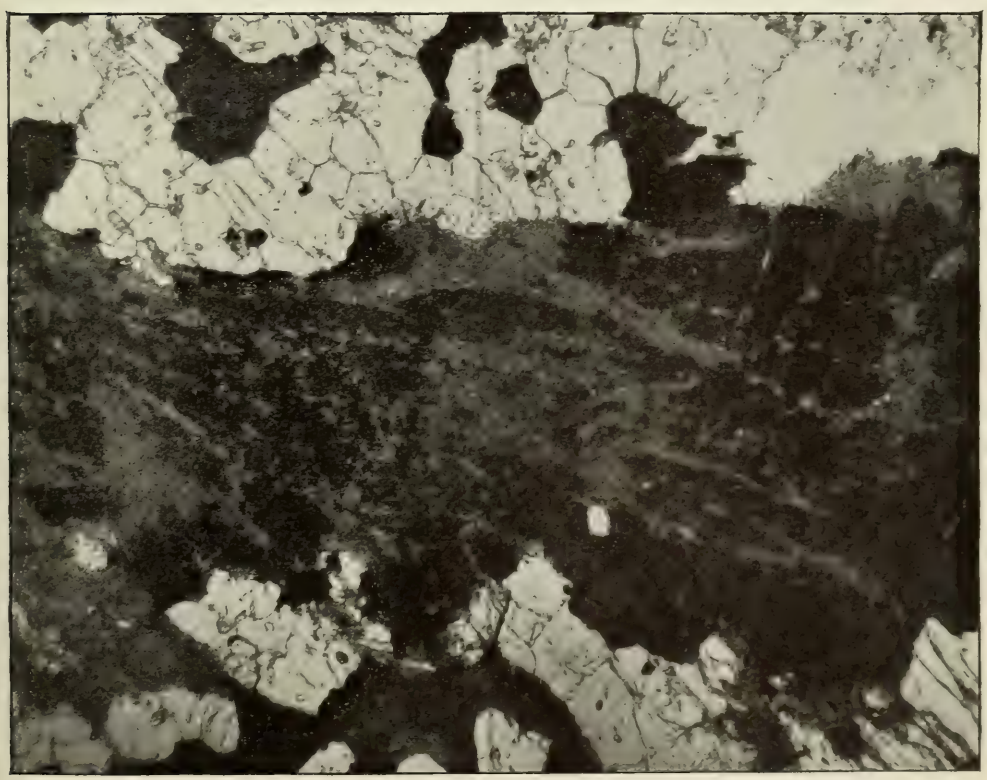


Fig. 2 Photomicrograph of schistose wall-rock, Cole mine, with pyrite developed in a chlorite vein and, to a less extent, throughout the rock. The white mineral is almost entirely quartz. Some cataclastic structure is shown. (Magnified 27.5 diameters)

entirely incloses adjacent areas of quartz in perfect optical continuity, thus clearly showing a replacement of quartz with no mechanical disturbance. Two large grains of pyrite with small branches attached suggest very strongly an older generation with a younger growing upon it. This phenomenon is worthy of special note in this case since it is very exceptional in the material examined.

That the pyrite has crystallized after the other minerals is obvious and there can be no doubt that it has replaced an equivalent amount, not only of chlorite, but of the much more stable and resistant quartz.

A similar rock, but rather more massive, contains a much larger amount of pyrite in large bunches connected by stringers and veinlets. Thus to the unaided eye the pyrite appears to be secondary, while as there is nothing to suggest preexistant cavities other than minute cracks it seems equally clear that it must be a replacement. In thin sections the rock is similar to the last but has little tourmalin, is decidedly kataclastic and has more chloritic alteration. Pyrite is much more abundant in scattered grains, rods and branching aggregates, commonly in association with chlorite, while the section is traversed by a vein of chlorite in which the abundant pyrite ranges from large solid masses to rods and shreds that might almost be called fibrous (figure 2).

The greenish chloritic alteration runs all through the section in the spaces between cracked quartz grains, at whose expense it seems to have developed. Considerable sericite is present, appearing as tufts and shreds in quartz and chlorite, after which it is secondary. It also forms narrow veins around, and fills cracks in, many of the pyrite masses, indicating that the sericite is at least in part younger than the pyrite. Thus the microscopic evidence agrees with that obtained by the naked eye in pointing to a secondary origin for the pyrite, replacing the original minerals which also show pronounced chloritization.

A specimen of rich ore very similar to ores at other mines is a medium grained, dark rock with abundant pyrite unevenly disseminated through it in crystals and irregular grains and sometimes in large masses, like those in the preceding specimens. The dark color of the rock is largely due to fine scales of graphite, which are exceedingly abundant. A thin section shows a large amount of quartz, little orthoclase and no plagioclase. Muscovite, in part at least secondary, is fairly abundant. There is much pale green, nearly or quite isotropic chloritic alteration product, and abundant graphite. The roughly equidimensional grains of pyrite give little

hint of their origin or relation to other minerals except that occasionally they seem to be molded upon the mica.

The rusty gneiss underlying the ore is strongly foliated and in hand specimens shows abundant mica, quartz, some pyrite and garnet. Thin sections show quartz, muscovite, bleached and altered biotite, much garnet and chlorite, little or no graphite, and considerable pyrite. The latter is sometimes molded upon other minerals as in figure 4.

In chlorite there is sometimes a very free growth of pyrite, as shown in figure 5.

From these facts it is apparent that the pyrite has crystallized in its present position after all the other minerals, including the secondary chlorite but excepting sericite, were formed. This of course makes the deposition of the pyrite subsequent to the metamorphism which converted the Grenville sediment into the existing gneiss, since the chlorite in which the pyrite has grown is an alteration product of the metamorphic minerals. This is an important step toward determining the origin of the deposits if it can be proved that the foregoing relations are not simply the result of circulation and recrystallization of pyrite already present in the rock long before this final precipitation.

THE HENDRICKS MINE

About two miles northeast of the Cole mine, on the Hendricks farm, are some small openings of pyrite which have never got beyond the stage of prospects, but are nevertheless of interest in their bearing upon the problem of genesis. Here again, as at the Cole mine, the pyrite deposits lie in the midst of Grenville rocks with no large masses of igneous rocks near by. The pyrite is near the bottom of a heavy body of fine, strongly laminated Grenville gneiss, the ore being simply a pyritous and therefore "rusty" part of the formation. This gneiss makes a high ridge north of the mine.

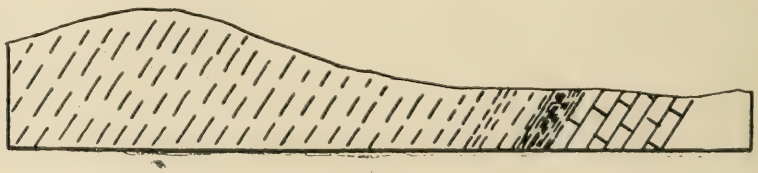


Fig. 6 Rusty gneiss and ore shown by heavier shading

while to the south there is a wide gap in outcrops except for some fifty feet of typical limestone almost immediately beneath the ore. The section is diagrammatically represented with little reference to scale in figure 6.

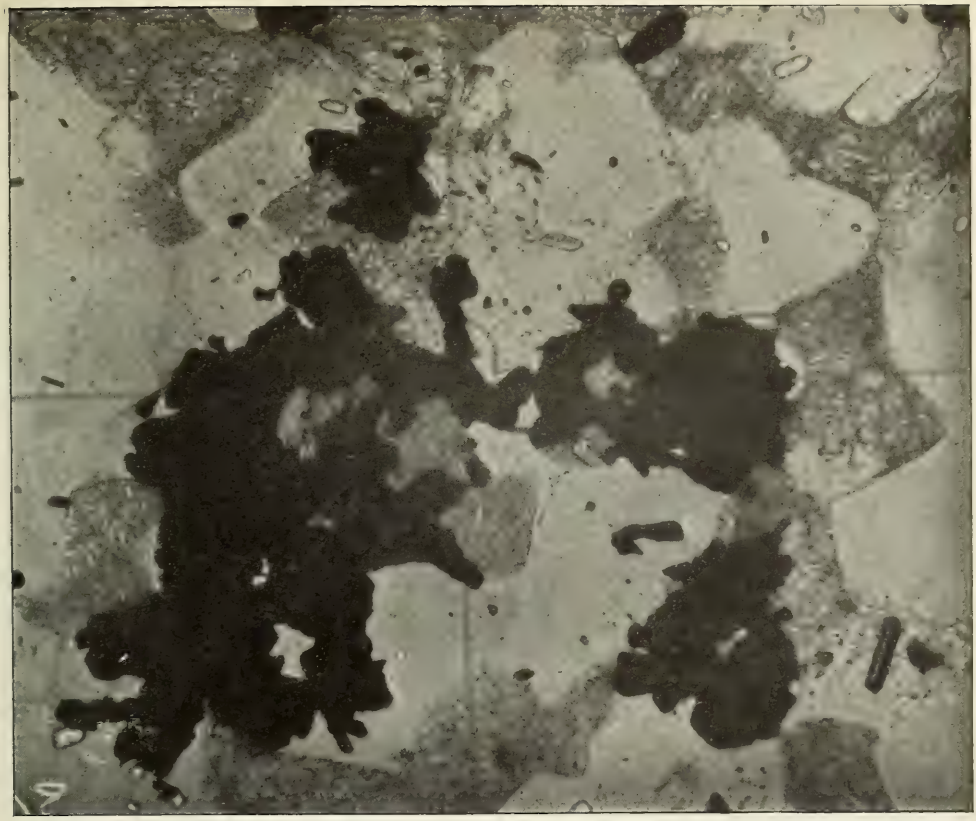


Fig. 3 Photomicrograph of fine-grained schistose wall-rock, Cole mine, with branching masses of pyrite, and quartz, sericite, chlorite and tourmalin. (Magnified 154 diameters)

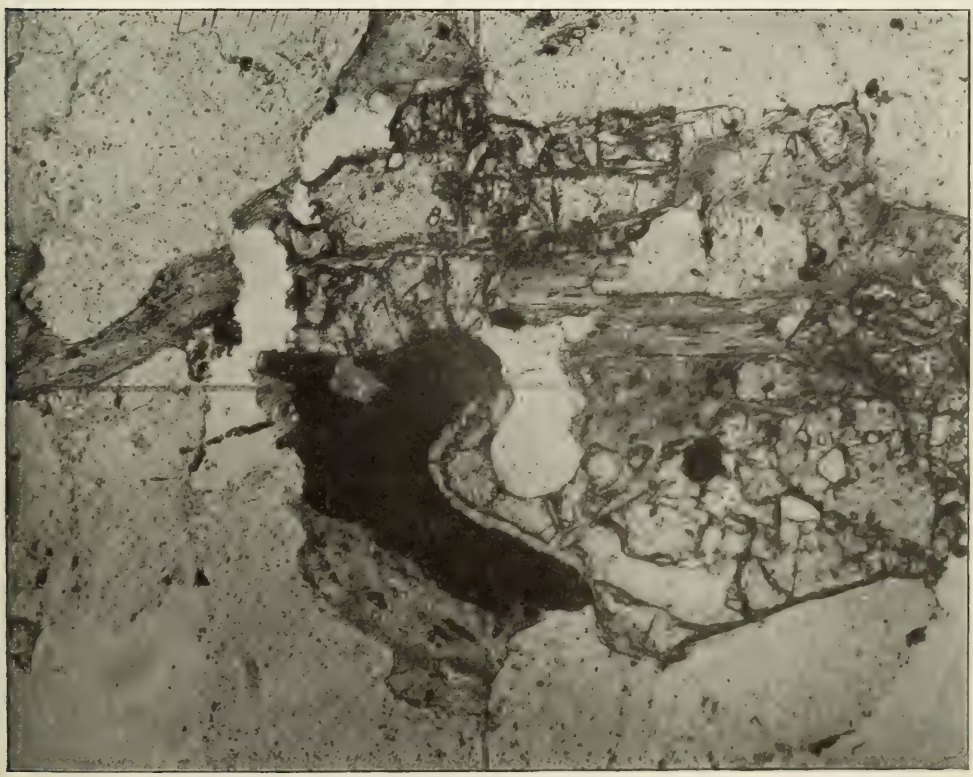


Fig. 4 Photomicrograph of rusty gneiss underlying the ore at the Cole mine, showing pyrite molded upon garnet. (Magnified 83.5 diameters)

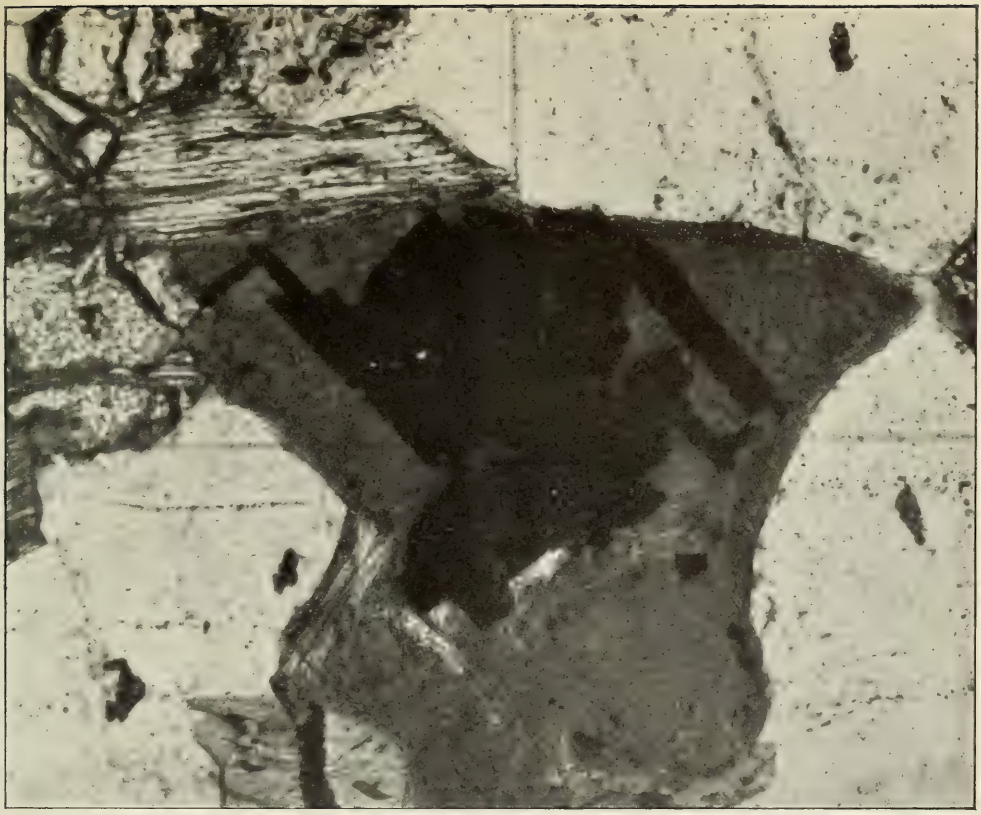


Fig. 5 Photomicrograph of rusty gneiss underlying the ore at the Cole mine, with pyrite growing in chlorite, surrounded by quartz, garnet and bleached mica. (Magnified 154 diameters)

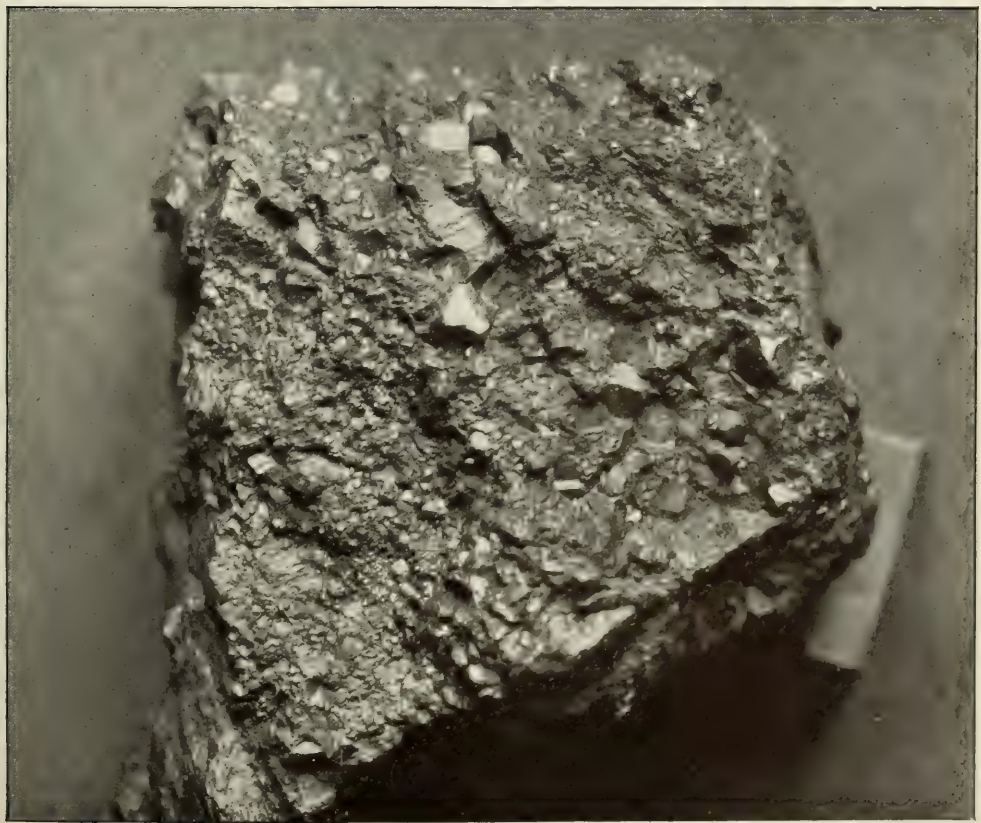


Fig. 7 Ore at the Hendricks mine, with crystals of pyrite in a chloritic aggregate. (9/10 natural size)

The gneiss in the hill is typical Grenville and is confidently classed as sedimentary, and thus the ore body lies wholly within sedimentary rocks. Pegmatite, however, is abundant, appearing as irregular masses but more commonly injected in thin sheets parallel to the banding of the gneisses. It is particularly abundant in immediate association with the ore but apparently contains no pyrite. This is so unlike other localities, however, that it is probable pyrite was overlooked. The ore appears to be merely a modification of the ordinary gneiss, containing large, but variable, amounts of pyrite. There is a gradual transition from gneiss to ore, no sharply defined ore body being present.

More than at any other mine, the pyrite tends to occur in distinct crystals which seem to form quite regardless of surrounding minerals. This is particularly true of a variety of ore consisting of a very fine chloritic aggregate, evidently an alteration product, through which are scattered abundantly quite perfect crystals of pyrite, seldom more than half an inch in diameter, and showing nothing more complex than cube and pyritohedron, as far as noticed (figure 7). This is evidently an extreme case of the tendency shown at all mines for the pyrite to crystallize more perfectly when in a chloritic matrix. As at the Cole mine, graphite is a constant accompaniment of the pyrite, though quite unevenly distributed. A considerable amount of milky white quartz is present, of vein origin and younger than the pyrite crystals, while there has been a still later deposition of calcite in limited amount.

Thin sections confirm the conclusion drawn from field study that the ore is a part of the Grenville gneiss enriched in pyrite at the expense of the other minerals. The ordinary gneiss on the ridge is a rather fine grained aggregate of quartz, feldspar, both orthoclase and plagioclase, abundant muscovite and a pale brown mica, probably phlogopite. There is a little graphite and an occasional grain of pyrite. A similar rock, close to the ore, is darker in color, very quartzose and micaceous, with more graphite and considerable pyrite. The mica is changing into a greenish, chloritic material of weak or indistinguishable double refraction, and sometimes with a fibrous texture. This same substance also grows in quartz and feldspar, together with small quantities of sericite. There is also present some colorless pyroxene and a dark brown mineral, probably rutile.

In the sections, as in hand specimens, the pyrite seems to have grown freely into other minerals and only occasionally is molded upon them. Although in somewhat elongated and branching aggre-

gates, it nearly always has its margins bounded by crystal faces (figure 8). There are some delicate aggregates of small crystals clustered in such a way as to indicate that they have crystallized within the rock after all mechanical disturbances. This rock is a perfectly typical rusty gneiss of the Grenville, and at the same time, when compared with the preceding rock, it is clearly the first stage in the conversion of a similar rock into ore.

Next, a lean ore shows in the section all the mica changed to chloritic material. There is a little rutile, but no graphite. The pyrite is in large areas, bounded by crystal outlines not of single crystals, but of many crystals in a single mass as shown in figure 9. Feldspar is practically absent, and the abundant quartz is largely, if not wholly, a secondary infiltration.

Another section of lean ore shows large single, but somewhat incomplete crystals of pyrite with considerable feldspar altering to sericite, and much green chlorite. The larger crystals of pyrite partly or wholly inclose grains of the other minerals, clearly indicating an incomplete replacement of the latter by the pyrite (figure 10). Another section differs from this only in the abundance of graphite, resembling in this respect many specimens from other localities, while the Hendricks material, on the whole, is rather poor in this constituent. Another hand specimen shows much vein quartz and rather perfect crystals of pyrite. In thin sections the latter is seen to be crushed and the cracks infiltrated with calcite.

As bearing upon the question of genesis of the pyrite deposits, the most striking phenomena exhibited at this locality are the close association of the ore body with crystalline limestone, the gradation of ore into rusty gneiss and ordinary fine laminated gneiss, the irregular distribution of graphite in the ore and often its entire absence, the crystalline character of the pyrite apparently assumed late in the history of the rock and but little controlled by other minerals present, the alteration of mica to a chloritic material, which seems to grow also at the expense of other minerals, and finally the presence of considerable vein quartz. The small amount of calcite appears to be of minor importance, but on the other hand it is possible that the injection of pegmatite in the gneiss of the adjacent ridge is a vital factor and its presence must be kept in mind in framing hypotheses to account for the ore bodies. The crushing of pyrite shown in one section simply serves to accentuate the extreme rarity of this phemonenon throughout the region, for while there has doubtless been considerable disturbance subsequent to the formation

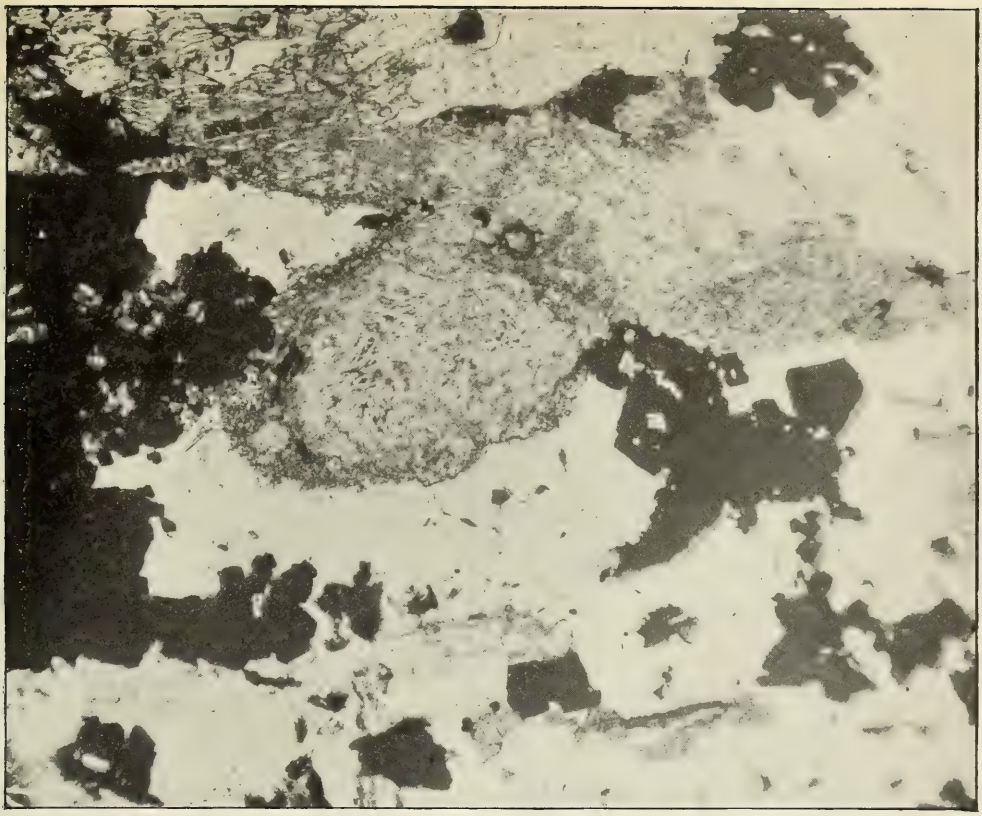


Fig. 8 Photomicrograph of rusty gneiss close to ore, Hendricks mine, with irregular masses of pyrite scattered through quartz, pyroxene, chlorite and sericite. A little mica and a few flakes of graphite are present. (Magnified 27.5 diameters)

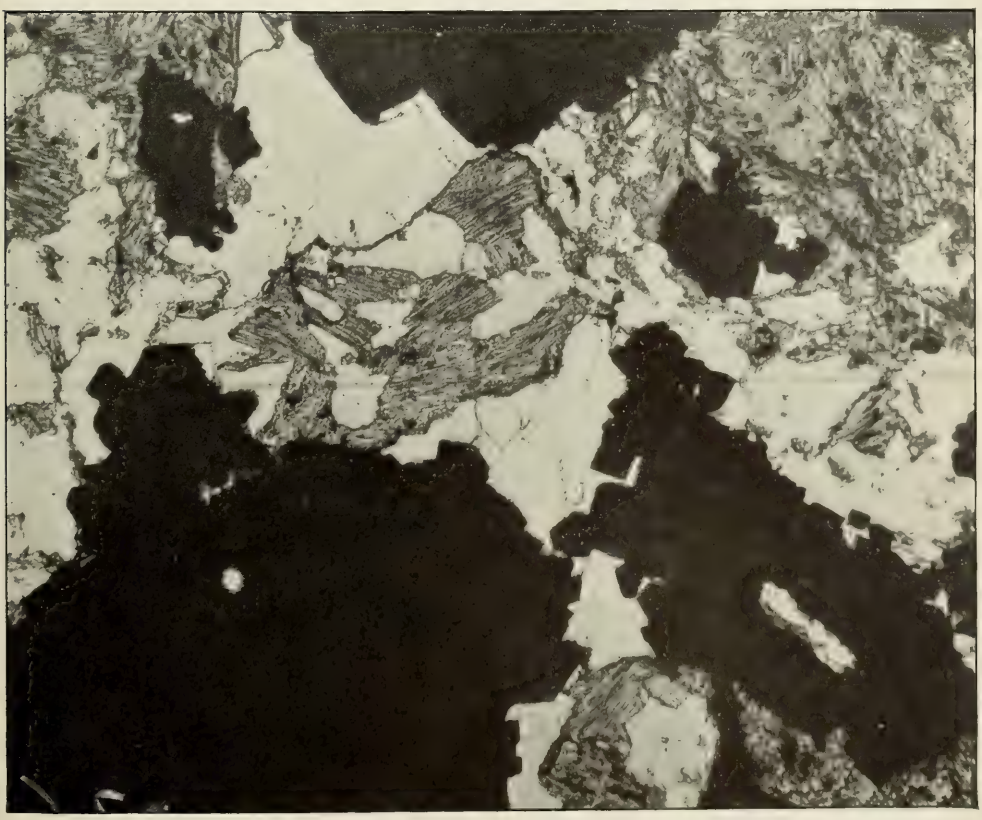


Fig. 9 Photomicrograph of lean ore, Hendricks mine. Large masses of pyrite, bounded by sharp crystal faces, with quartz, chloritized mica and a little rutile. (Magnified 27.5 diameters)

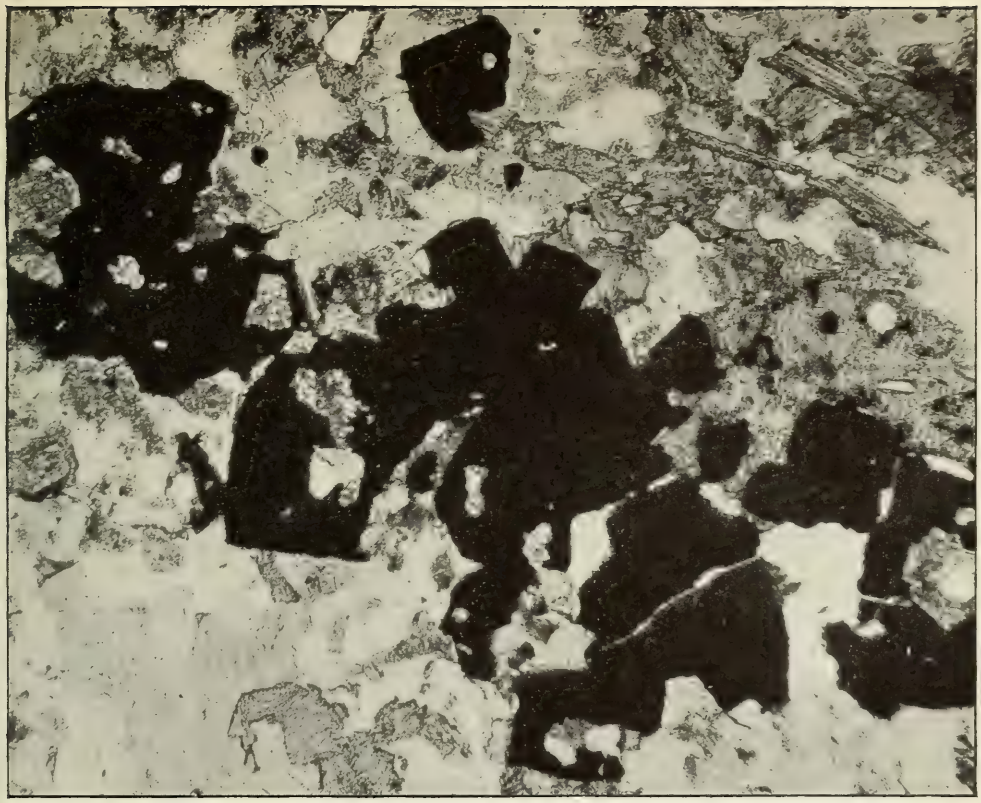


Fig. 10 Photomicrograph of lean ore, Hendricks mine, with incomplete crystals of pyrite developed in chlorite, bleached mica, kaolinized feldspar (in part plagioclase) and quartz. A few cracks shown in the pyrite were made in grinding the section. (Magnified 27.5 diameters)

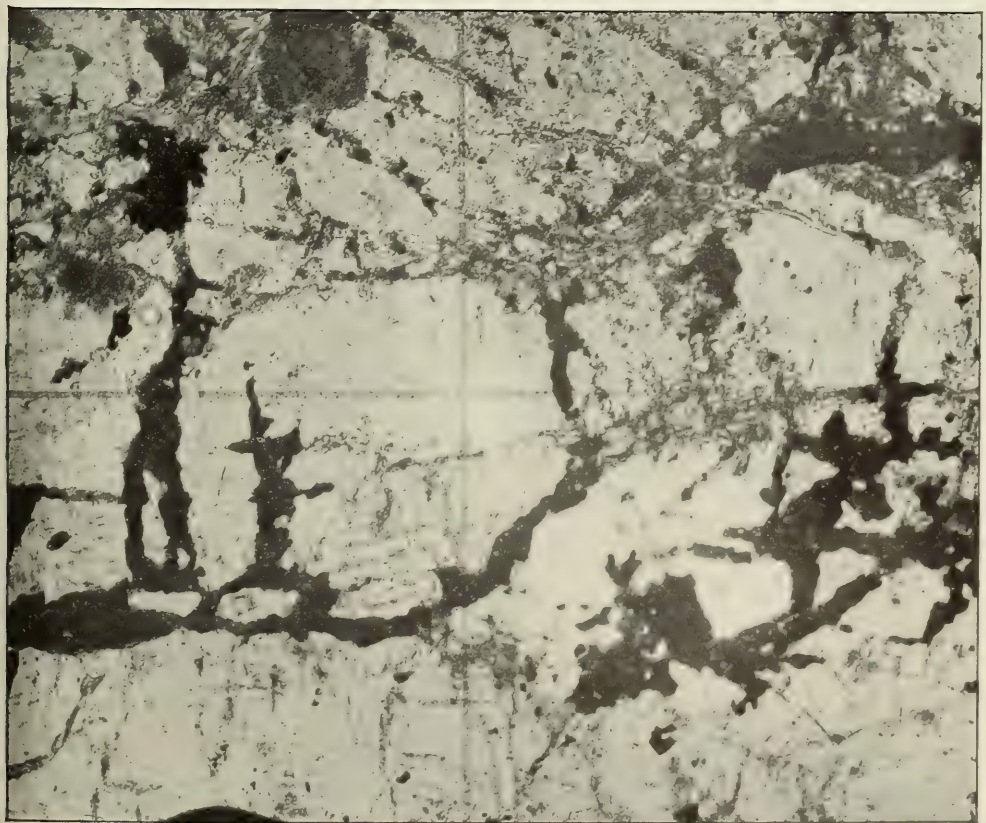


Fig. 12 Photomicrograph of pyritiferous pegmatite, Styles mine, with pyrite, chlorite and sericite developed along cracks in feldspar. (Magnified 83.5 diameters)

of pyrite, it has not been of such a nature as to effect a comminution of the rock constituents.

THE STYLES MINE

On the Styles farm, a few miles farther northeast, another small prospect has been opened. Here again the pyrite is in the rusty gneiss and its Grenville association is strikingly shown by the fact that this gneiss is hardly more than twenty feet thick and has limestone both above and below, as shown in figure 11.

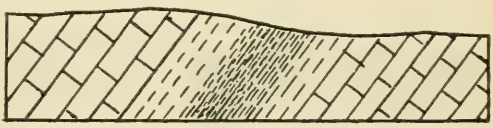


Fig. 11 Rusty gneiss and ore heavily shaded

In addition to these rocks considerable pegmatite, carrying a peculiar light brown tourmalin, is present, a great deal lying on the dump. While much of the pegmatite is free from pyrite, other specimens show considerable quantities of the mineral. Indeed some of the pegmatite is a rather lean ore of pyrite, while the rich ore seems again to be merely a part of the rusty gneiss carrying an unusually large percentage of pyrite. As at the Cole mine, graphite is conspicuous in the richer ore which also contains large amounts of grayish green, soft chloritic material not conspicuous at the Cole mine, but very abundant and characteristic at other localities. Indeed, in many cases, it appears that the enrichment of ore is roughly proportional to the development of this chloritic product.

Thin sections of the Styles pegmatite show moderately developed cataclastic structure, which is of particular interest since it evidently precedes the deposition of pyrite. The latter, with some chlorite and sericite, spreads in a network through the cracks between the mineral fragments recementing the fractured rock. But the process, instead of stopping at this point, evidently continued as an actual replacement of the mineral grains by pyrite, thus increasing the latter at the expense of the former (see figures 12 and 13). This may continue to the production of a rich ore. Indeed, among the specimens collected the richest is quite probably a highly altered pegmatite converted into an ore by this process of replacement. As at the other localities, graphite is quite generally present.

A section of another specimen of pegmatite shows the same kataclastic structure, with pyrite filling cracks and from them spreading into and replacing the original minerals. There is also a more perfect development of crystal form of pyrite when in contact with chlorite rather than with primary minerals. This relation as already indicated is shown by sections from several localities and strongly

suggests that the soft chlorite is easily displaced mechanically, as well as chemically, by the pyrite, a conclusion which of course implies the later formation of the last named mineral. That this is true of at least part of the pyrite, there can be no doubt. The section in question is a cataclastic pegmatite, similar to that from which figure 13 is taken, and shows the same development of pyrite, beginning in cracks and extending from them into the surrounding solid minerals.

THE FARR MINE

The Farr mine, some two miles northeast of the Styles mine, resembles the latter very closely in its geological relations. Here again the ore is part of a narrow band of rusty gneiss hardly exceeding thirty feet in thickness, with limestone above and below, while again pegmatite is conspicuous. There is a large mass of the latter rock, free from pyrite, some twenty feet from the shaft, while in the dump there is abundant pegmatite containing much pyrite. As the latter increases in quantity it passes into fairly rich ore. Judging from what could be seen when the locality was visited, the pyritiferous pegmatite is an important part of the ore. The rock contains an abundance of the light brown tourmalin seen in the pegmatite of the Styles mine. This mineral is conspicuous in some of the strongly replaced specimens.

A section of the pyritiferous pegmatite shows large areas of pyrite from which veinlets extend out into the surrounding quartz and feldspar. Figure 14 shows an example where such veinlets traverse what was originally a single individual of quartz, without the slightest disturbance in optical orientation of the now separated parts. It is clear that these parts have not been moved with reference to each other, but that the pyrite has replaced an equivalent amount of quartz, the process starting along minute cracks. Its continuation would lead to a complete replacement of quartz by pyrite, which is doubtless the manner in which the larger masses of pyrite have originated. An even better case, perhaps, is shown in figure 15 where the veinlets of pyrite traverse several individuals of quartz, with no disturbance of their optical orientation and continue down through several other grains, outside of the field of the microscope. The only section of schist from this locality examined under the microscope shows, in addition to the ordinary quartz, feldspar and mica, sillimanite, tourmalin, garnet, some pyrite and graphite. It is evidently a Grenville sediment, but presumably has been affected by the pegmatite, as indicated by the tourmalin.

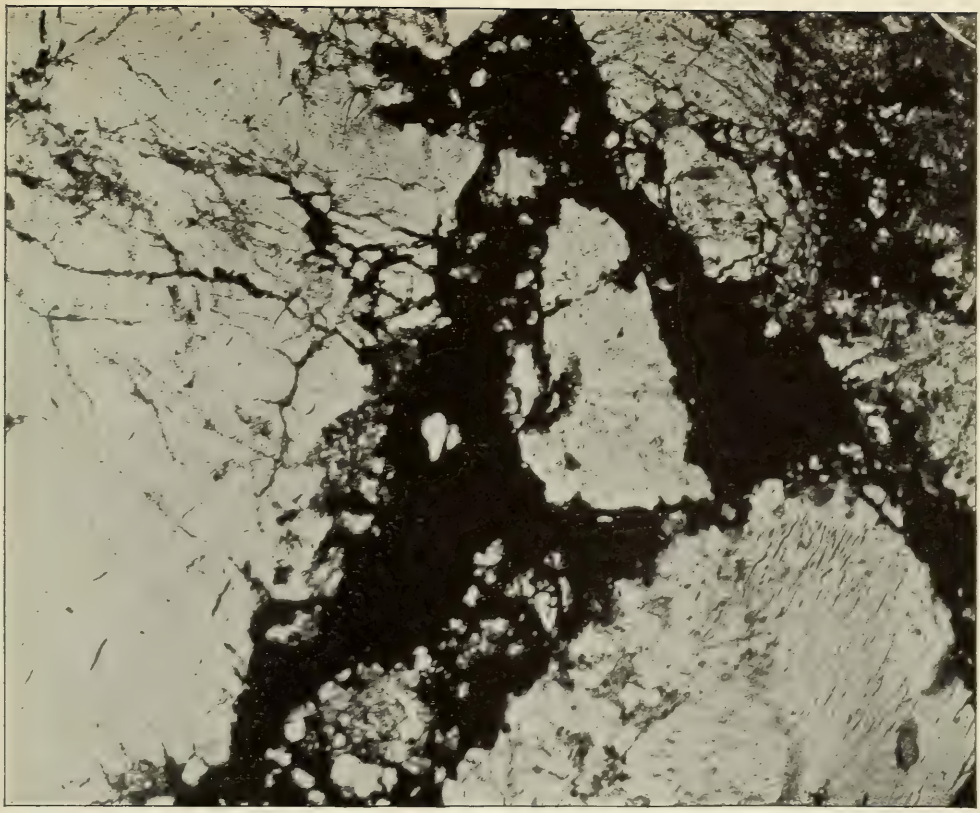


Fig. 13 Photomicrograph of pyritiferous pegmatite, Styles mine. Quartz and feldspar showing cataclastic structure and subsequent development of pyrite. (Magnified 27.5 diameters)

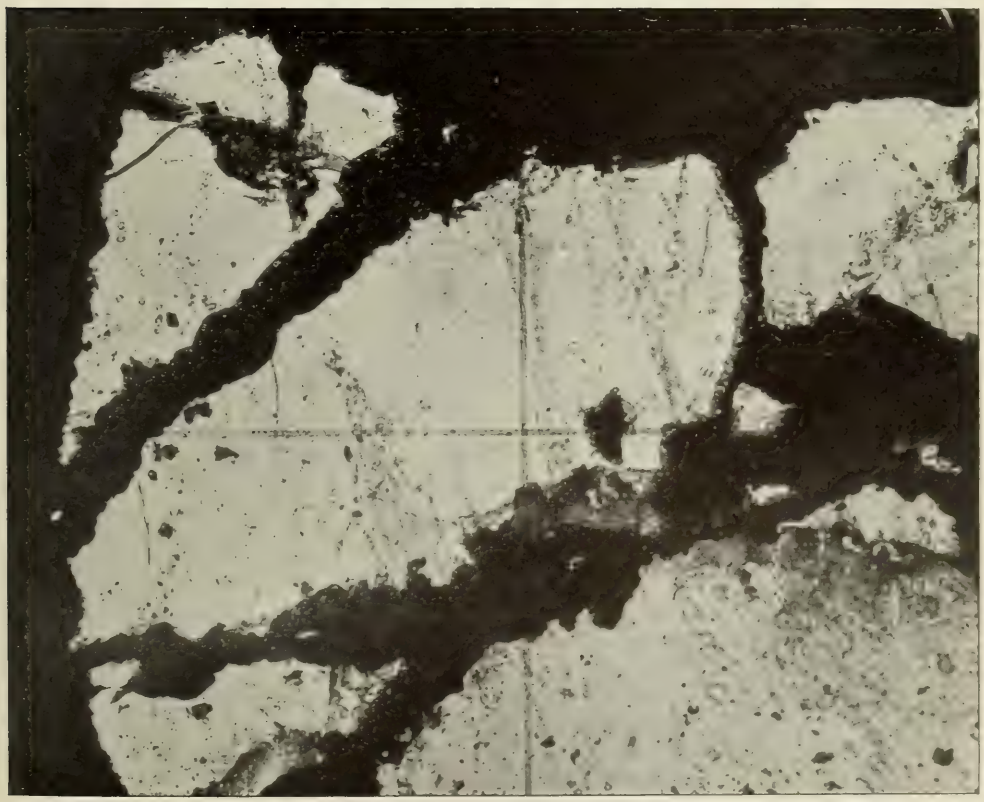


Fig. 14 Photomicrograph of pyritiferous pegmatite, Farr mine, showing veinlets of pyrite cutting a single individual of quartz without disturbing the optical orientation. (Magnified 60.5 diameters)

Fig. 13 Photomicrograph of pyritiferous pegmatite, Styles mine. Quartz and feldspar showing cataclastic structure and subsequent development of pyrite. (Magnified 27.5 diameters)

Fig. 14 Photomicrograph of pyritiferous pegmatite, Iron mine, showing veinlets of pyrite cutting a single individual of quartz without disturbing the optical orientation. (Magnified 60.5 diameters)

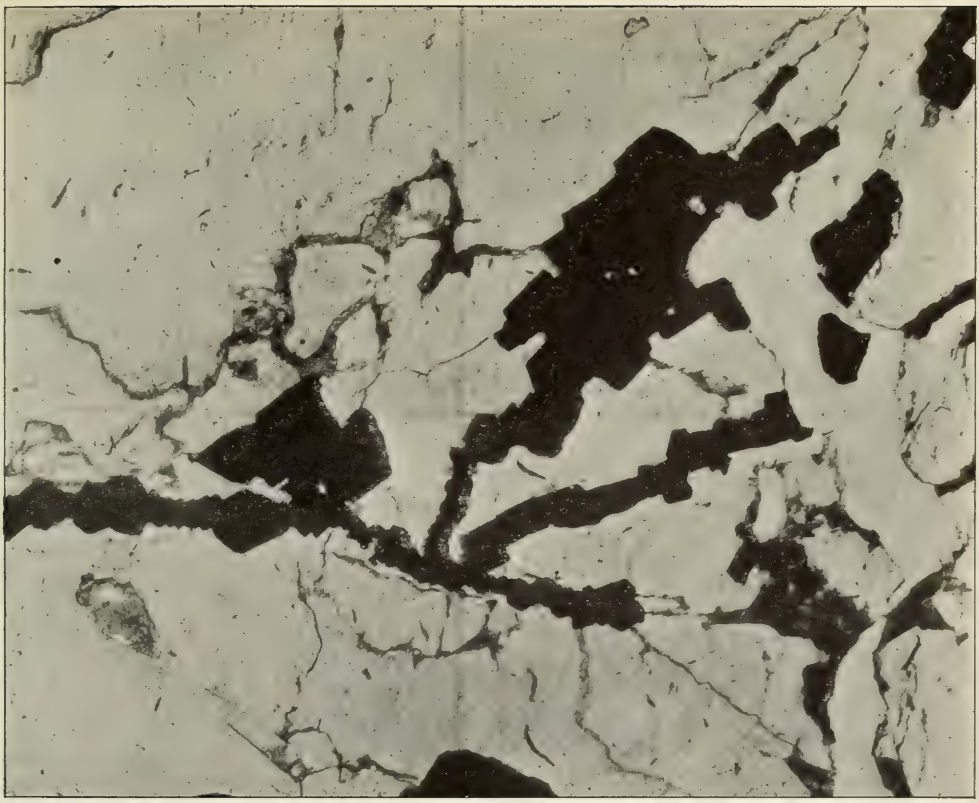


Fig. 15 Photomicrograph of pyritiferous pegmatite, Farr mine, with branching veinlets of pyrite cutting several individuals of quartz without disturbance of optical orientation. Crystal boundaries of pyrite, very sharp. (Magnified 27.5 diameters)

Fig. 17 Ore, Stella mine. A rather fine, granular aggregate of pyrite, chlorite, graphite, quartz and feldspar. (9/10 natural size)

While in all these cases the pyrite is manifestly introduced into its present position very late in the history of the rock, the question arises: Has it been brought into the rocks from an outside source subsequently to their formation or is it an original constituent which has merely undergone secondary migration and recrystallization? The answer to this question may be different for the pyrite in gneisses, on the one hand, and for that in pegmatites, on the other, but as in either case the whole problem of the origin of the ore bodies is involved, the consideration of the matter is deferred for the present.

THE STELLA MINES

About five miles northeast of the Farr mine are located the Stella mines, much the most extensive workings of the pyrite region. In many respects the geology is similar to that of the localities already mentioned, but at the same time there are some striking differences. The mines lie in a Grenville belt, with extensive development of rusty gneisses southward and heavy limestone on the north. At the mines the exposed section begins on the south with a coarse, rather massive, very dark hornblende gneiss, quite unlike any rock shown at the other localities. This rock forms a ridge south of the new Anna shaft, on the lower ore body, which is the next member of the series and which in its natural exposures is a typical rusty gneiss. Above this comes another gneiss forming a high ridge between the two ore bodies. At the bottom, this rock is light gray and appears fairly acid, but higher up it becomes dark and hornblendic, resembling closely the lower hornblende gneiss, and then finally becomes acid again toward the top. Next comes the rusty gneiss of the upper ore body, and this is followed in turn by a light gray mica gneiss, making up a considerable ridge, with limestone to the north. This generalized section is represented in figure 16.

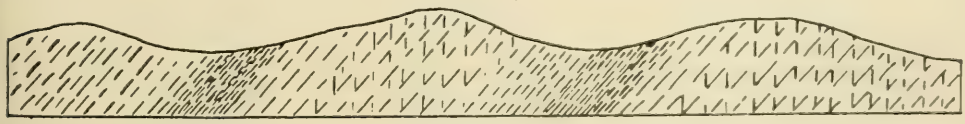


Fig. 16 Hornblende gneiss shown by crossed hachures

As compared with sections at the other localities, the entire absence of limestones is perhaps the most striking feature. The two distinct main ore horizons are also worthy of note, while perhaps more important is the great development of gneiss. The high ridge of gneiss above the ore at the Hendricks mine is in some ways

analogous to the mica gneiss above the upper ore at Stella, but the rocks at the two localities are quite unlike, while at none of the previously described localities is there anything resembling the dark, hornblende gneiss in the present section. The ore deposits themselves and the immediately associated rock appear without doubt to be of the same general type as elsewhere.

While in the preceding cases it has been clear that all rocks concerned, with the exception of the pegmatites, were of the generally accepted Grenville sedimentary types, at Stella this is far from being the case, and for the first time the question of the origin of extensive rock bodies presents itself.

The problem begins with the dark, hornblendic gneiss at the bottom of the section. This is a type of rock that might result from the metamorphism of a sediment or of a basic igneous rock. In the present case conclusive evidence is not afforded for deciding between the alternatives, but from a general knowledge of the region, and more particularly from evidence to be given in connection with another locality, the writer inclines to regard the rock as igneous and closely related to the gabbros of the region. Yet this view meets difficulties when the gneiss between the ore bodies is examined. The central part of this can hardly be distinguished from the supposed gabbro, but it shades both upward and downward into a light gray, rather acid gneiss that might well be interpreted as a Grenville sediment. Evidently this difficulty might be explained in diverse ways, but without very detailed study speculation would be fruitless. Finally, the mica gneiss above the upper ore is regarded as probably sedimentary, but on the other hand it too may be a metamorphosed intrusive so far as can be judged by its structure and mineralogical composition.

While these unsettled questions obviously are important in their bearing upon the history of the ore deposits, they are not so vital as they would be were this the only locality for the pyrite or did the deposits here differ markedly from those at the other localities. As a matter of fact, this latter is conspicuously not the case, the ore bodies at Stella agreeing in all important details with those already described. This being true, it follows that the nature of the ore deposits is independent of the immediate presence of large intrusive masses, since none occur at the other localities, and the probable and possible intrusions at Stella have exerted no noticeable modifying influence upon the ore bodies. The latter are of rough lens shape,

dipping to the north with the country rock. At present ore bodies lying at two distinct horizons, separated by about a thousand feet across the strike, are worked, and the superintendent of the mines, Mr J. Tonkin, informed the writer that a total of nineteen ore bodies of varying thickness had been shown by diamond drilling. According to Mr F. T. Rubidge, vice president of the St Lawrence Pyrites Co., to whom the writer is indebted for many courtesies, only four or five of the pyritiferous horizons afford workable ore-bodies. They run about twelve feet in thickness, but may reach as high as thirty feet. In the Stella mine, the ore, about ten feet thick, extends about eleven hundred feet along the strike and has been worked nine hundred feet down the dip of 20°–30°. Considerable pyrrhotite occurs in this mine. In the Anna mine, the ore averages twenty feet thick and has been followed two hundred fifty feet down a 45° dip and twelve hundred feet along the strike. As elsewhere, the ore bodies are not sharply defined but fade gradually into the surrounding rock, which is impregnated with pyrite some distance from the ore proper. While the typical ore lies in the rusty gneiss, pyrite is disseminated rather generally through the rocks, and railroad cuts in the hornblendic gneiss south of the mines show strongly pyritiferous masses of irregular form, the pyrite being in a tough dark base. The same rock is also cut by many bands of pegmatite, both parallel to and across the foliation. These bands frequently carry pyrite in crystals and it also occurs in irregular branching veins in the gneiss.

The gneisses above and below the upper ore body carry a great deal of sheared pegmatite, mostly parallel to the foliation, and this carries some pyrite. Thus here, as elsewhere, the pegmatite is conspicuous. The same is true of graphite, for just as at the Cole mine, the tailings from the concentrator carry considerable amounts of this mineral, which also is more abundant in the ore and immediately adjacent rocks than farther from the ore bodies.

Hand specimens of the ore show a granular aggregate of pyrite, graphite and a gray, soft alteration product, together with some quartz and feldspar (see figure 17). Some specimens can hardly be distinguished from the material at the Cole mine but large crystals are less frequent at Stella.

Here and there vugs occur, lined with crystals of quartz, calcite and sphalerite, manifestly much younger than the pyrite and formed under quite different conditions.

A thin section of a rather lean ore from the Stella shaft, showing to the naked eye pyrite, graphite, quartz, feldspar and the usual soft gray material, under the microscope shows much nearly isotropic chloritic alteration product mingled with bleached mica and sericite. There is also considerable quartz and some untwinned feldspar. Graphite is abundant, much of it being inclosed in the pyrite though in one or two instances the latter mineral has grown between and forced apart plates of graphite. The pyrite is often in distinct crystals which apparently have been the last development in the rock unless it be the alteration products. As to the latter there is some uncertainty, for while the chlorite sometimes forms borders around or veins in pyrite there is a tendency, noted elsewhere, for the pyrite to have more perfect crystal form when in contact with chlorite, as though the latter were more yielding than the other minerals. Without doubt some of the chlorite, and probably most of it, antedates the pyrite, while the very pronounced formation of chlorite in the pyritiferous rocks, as compared with the average gneisses, strongly indicates a direct connection between chloritization and deposition of pyrite, as products of closely related and associated processes and conditions. So far as the evidence goes this rock seems to be a highly altered gneiss carrying unusual quantities of graphite and pyrite, the latter mineral having evidently formed very late, replacing the older minerals.

A section of richer ore differs greatly from the preceding, having even more graphite, and the pyrite developed almost to the complete exclusion of other minerals. The section is quite striking, showing the pyrite in distinct though interlocking crystals including abundant graphite, the interspaces being filled with sericite, secondary quartz and chlorite (see figures 18 and 19). Though as a whole so unlike the preceding section, this one shows remnants of greatly altered minerals of the gneiss and there can be no doubt that this rich ore is a part of the gneiss in which the processes of alteration and replacement have been carried to an extreme degree.

The immediate hanging wall of the Stella ore body is a fine-grained dark gray schist, with much graphite, shot through with tiny veins and bunches of pyrite (see figure 20). A thin section shows it to be a graphite-mica schist, the graphite giving the dark color. The mica is largely altered to a weak doubly refracting chlorite similar to that in the ores, and sometimes to a fibrous mass of yellowish brown color. Areas of this latter sometimes have a narrow border of sericite. Quartz is abundant, but feldspar is present only in very small quantity, and none with the twinning of plagioclase.

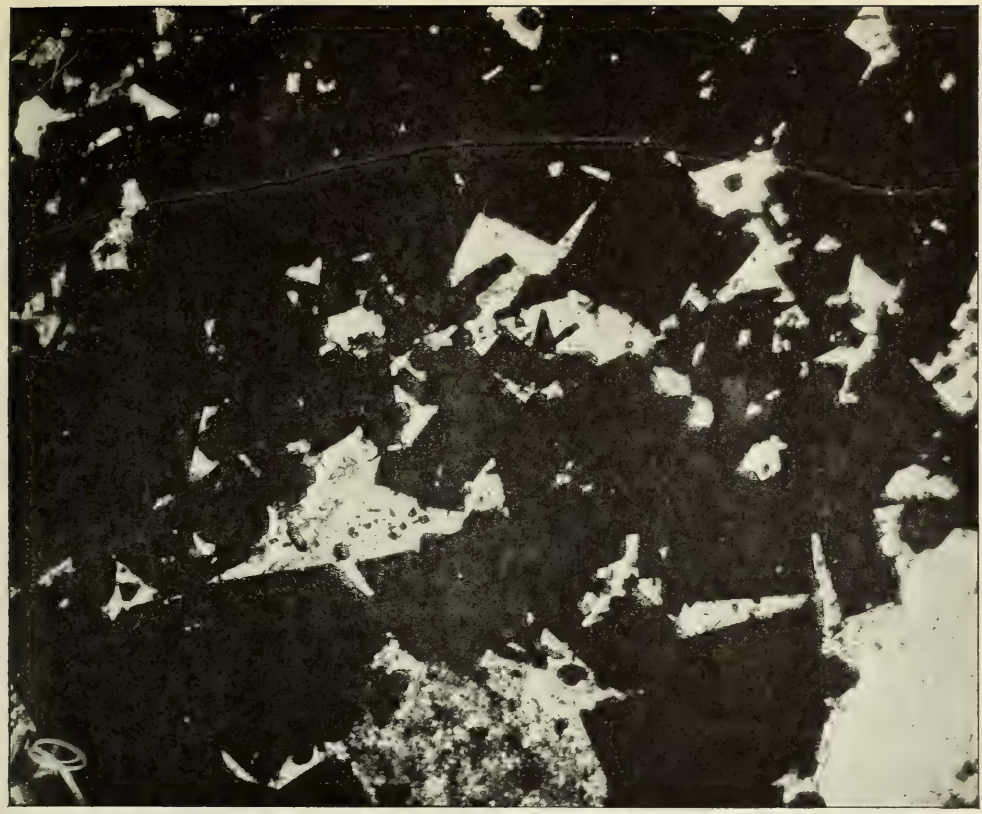


Fig. 18 Photomicrograph of rich ore, Stella mine. The spaces between the sharp crystals of pyrite are filled with sericite, chlorite and secondary quartz. Graphite is abundant in the pyrite, where, of course, it does not show in the photograph, and as small flakes and elongated grains in the light colored minerals. (Magnified 27.5 diameters)

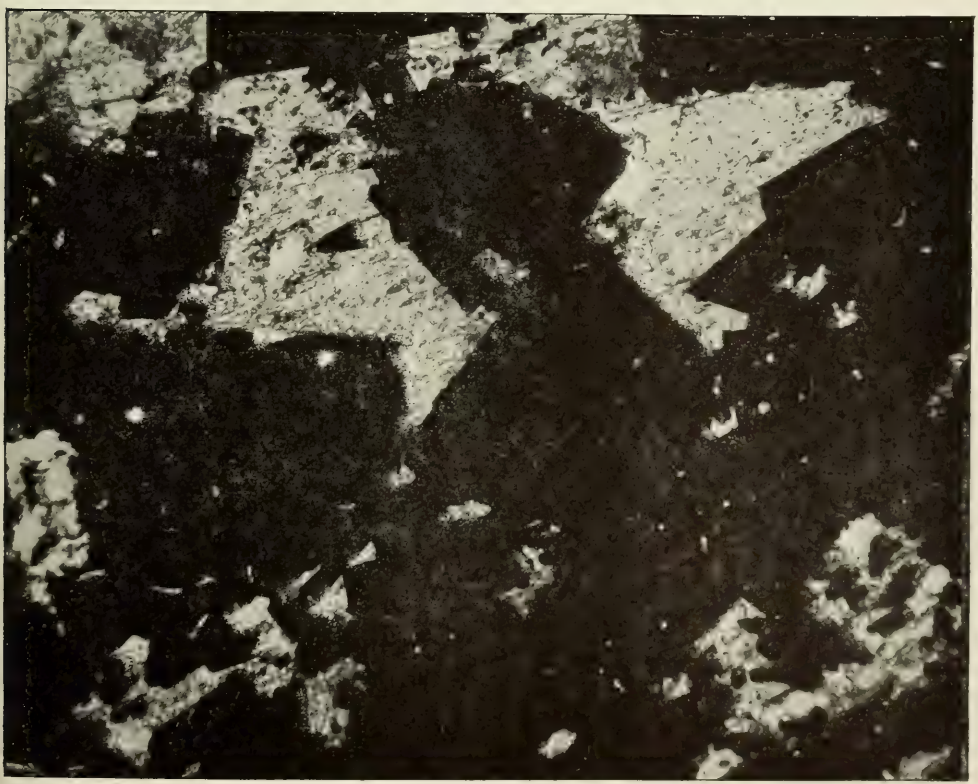


Fig. 19 Photomicrograph of rich ore, Stella mine. Rather large crystals of pyrite, with graphite, sericite, chlorite and secondary quartz. (Magnified 27.5 diameters)

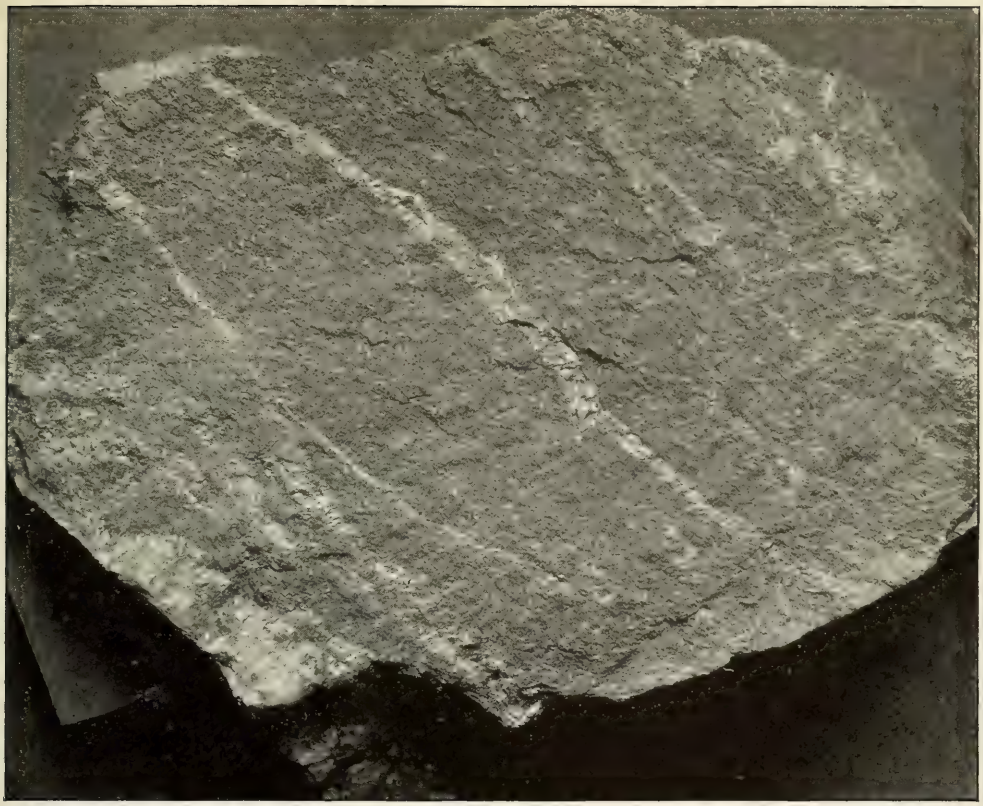


Fig. 20 Hanging wall, Stella mine. A fine-grained, dark, graphitic schist with veins of pyrite roughly parallel with the foliation. (9/10 natural size)

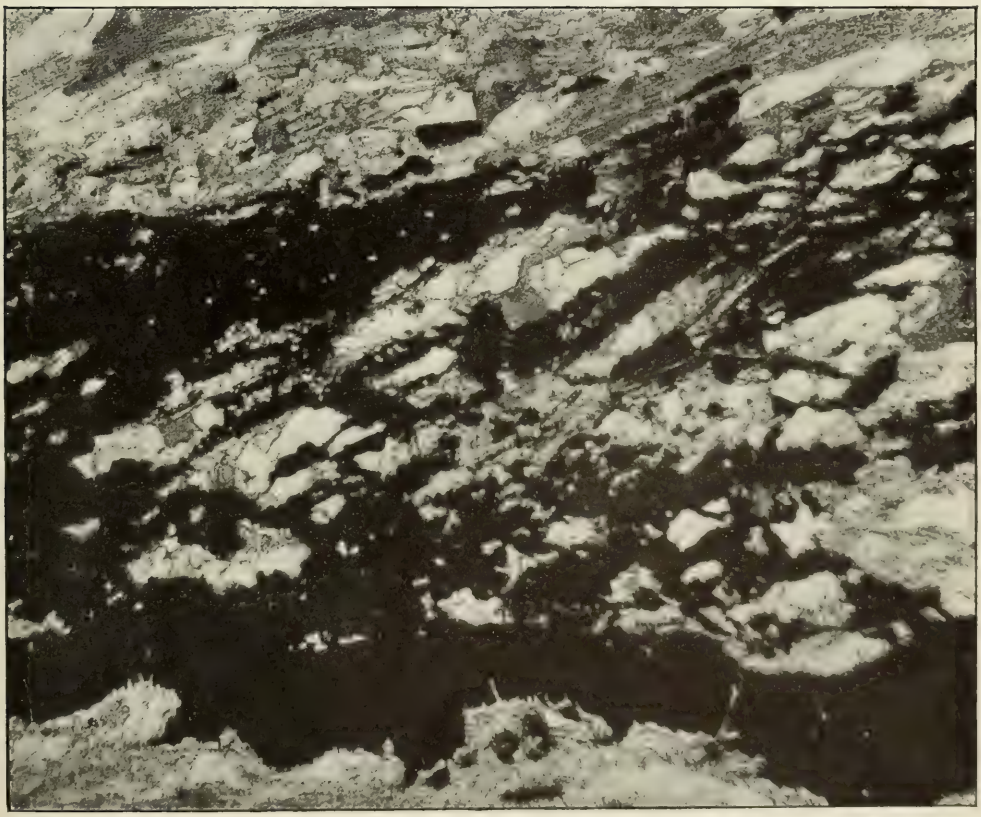


Fig. 21 Photomicrograph of hanging wall, Stella mine, showing a section of one of the pyrite veins of figure 20. Crushed quartz, chlorite, sericite, graphite and bleached mica, with pyrite in anastomosing veinlets, commonly bordered with a narrow fringe of sericite. (Magnified 27.5 diameters)

Graphite is abundant in scales and plates arranged parallel to the distinct foliation. Very commonly the graphite is somewhat split or even shredded, with chlorite, sericite and pyrite filling its interspaces into which they have evidently penetrated after the crystallization of the graphite. Like the graphite, pyrite is usually elongated parallel to the foliation, occurring most often in irregular grains. The section shows one of the veinlets seen in the hand specimen. It is made up of many fine anastamosing branches parallel to the foliation, the pyrite often showing distinct crystal form, while the outer margins of the vein are bordered with the sericite, whose position and arrangement are so evidently controlled by the vein that there can be no doubt that the sericite formed after the pyrite (see figure 21). That the latter mineral is a replacement of the ordinary constituents of the rock seems equally certain, being localized by solutions circulating in relatively porous parts of the rock. Had the replacement proceeded further an ore similar to those actually worked would have resulted.

The foot wall of the Stella ore body is a much coarser rock than the preceding, lighter colored and less prominently foliated. Large cleavage faces of feldspar are shown and many scattered grains of pyrite, but the pyrite veinlets so conspicuous in the hanging wall are lacking. In thin section, orthoclase is very abundant, passing over into the usual greenish, nearly isotropic, chloritic alteration product. Mica is thoroughly bleached, or completely altered to chlorite. There are some large areas of clear interlocking quartz possibly of vein origin. As a whole the section suggests a much altered, sheared pegmatite or injection gneiss. No graphite is shown and pyrite is not abundant, occurring as rather evenly disseminated, irregular grains which have a tendency to lie in chlorite, though there are abundant exceptions to this rule. The pyrite often shows a variety of skeletal growth, having the interspaces filled with chlorite and sericite, as shown in figure 22. Here there is a green, low refracting, chloritic alteration of feldspar clearly shown in process of formation, in the large feldspar grain on the right, and the same material filling cavities in the pyrite, near the bottom. Apparently this is older than the pyrite. Quite distinct from this is the filling of the spaces between the slender tongues of pyrite, by nearly colorless, strongly doubly refracting sericite, clearly younger than the pyrite. Pyrite is also seen replacing orthoclase and bleached mica. It is, perhaps, worthy of note that the disseminated pyrite is quite as abundant in this rock lacking graphite as in the hanging rock containing the latter in abundance.

Another specimen from the foot wall is a pyritiferous pegmatite quite similar to that at the Farr mine. It is a coarse aggregate of quartz, feldspar, green from alteration, and pyrite. In thin section it bears a strong resemblance to the preceding rock, but is coarser. The feldspar appears in all stages of alteration to the chloritic aggregate, and the pyrite occurs in this rather than in the quartz. At several points there is a pronounced skeletal growth (see figure 23) of pyrite in the chlorite, and here the latter mineral is somewhat fibrous, the fibers being perpendicular to the pyrite margins and meeting along a straight line in the middle of the narrow veinlike spaces. The conclusion seems unavoidable that this part of the chlorite has been deposited after the pyrite, or has undergone some rearrangement with reference to it. The latter is more probable. At another point, chlorite fills a narrow tortuous space between pyrite and quartz and between two adjacent grains of pyrite. Again, the fibrous chlorite has its fibers in clusters radiating from points along the margins of sharply banded pyrite crystals. Elsewhere the chlorite is clearly molded upon quartz. All these relations point to the mobility of the first-named mineral.

In general the microscopic examination of these sections strengthens the impression gained from other thin sections and in the field, that there is a close connection between the formation of pyrite and of chlorite. Many exceptions occur where pyrite is associated with fresh quartz and silicates but the ores proper all show the chloritic alteration. Practically the same thing may be said of pyrite and graphite, the latter being usually abundant but sometimes absent.

Sections of the gneisses adjacent to the mines shed little light upon their origin. They are aggregates of hornblende, plagioclase, a little pyroxene and some quartz and while, as previously stated, they are thought to be igneous rocks related to the gabbros, their true nature is open to question and they may be metamorphosed sediments. This latter view is favored by Newland.[1]

The material of one of the small pyritiferous bands in the dark hornblende gneiss, south of the Anna shaft, is of interest when compared with the large ore bodies. The hand specimen shows a rather coarse aggregate of hornblende, an amorphous black material and pyrite, the latter often in good crystals. The thin section shows some hornblende, greatly decomposed feldspar, apatite and an

[1] Newland, D. H. The Mining and Quarry Industry of New York. N.Y. State Mus. Bul. 120, 1908, p. 51.

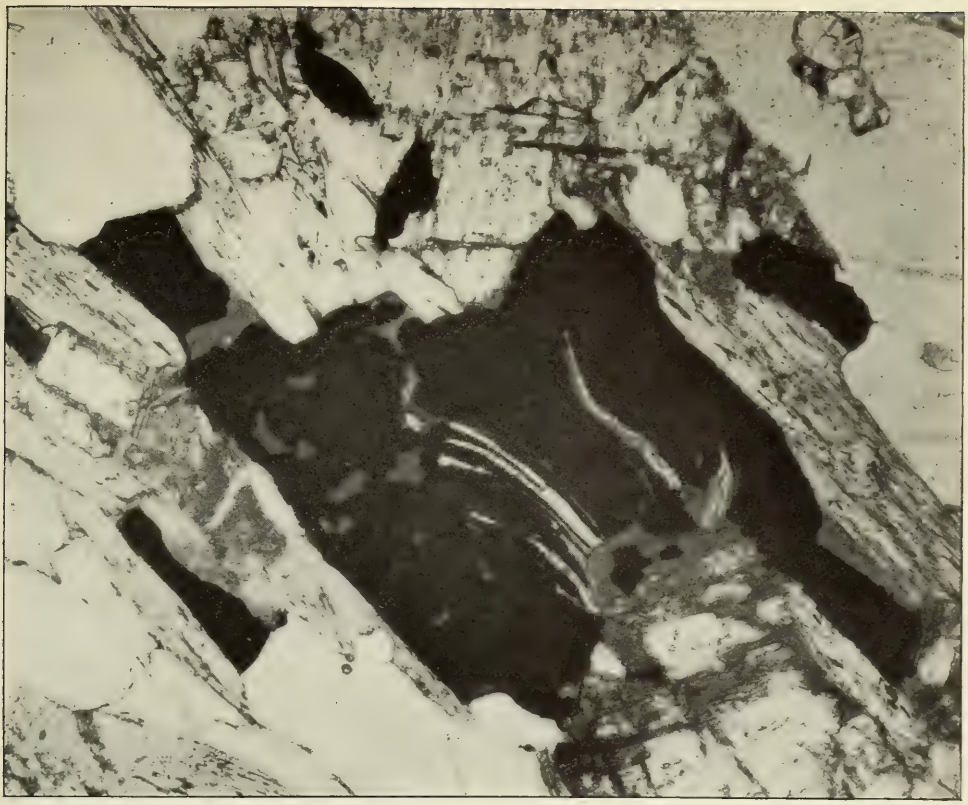


Fig. 22 Photomicrograph of foot-wall, Stella mine. Feldspar altering to green chlorite, which also fills cavities in lower part of pyrite. The latter has developed in slender, parallel tongues, between which sericite has formed. Pyrite is also shown in bleached mica and orthoclase. (Magnified 83.5 diameters)

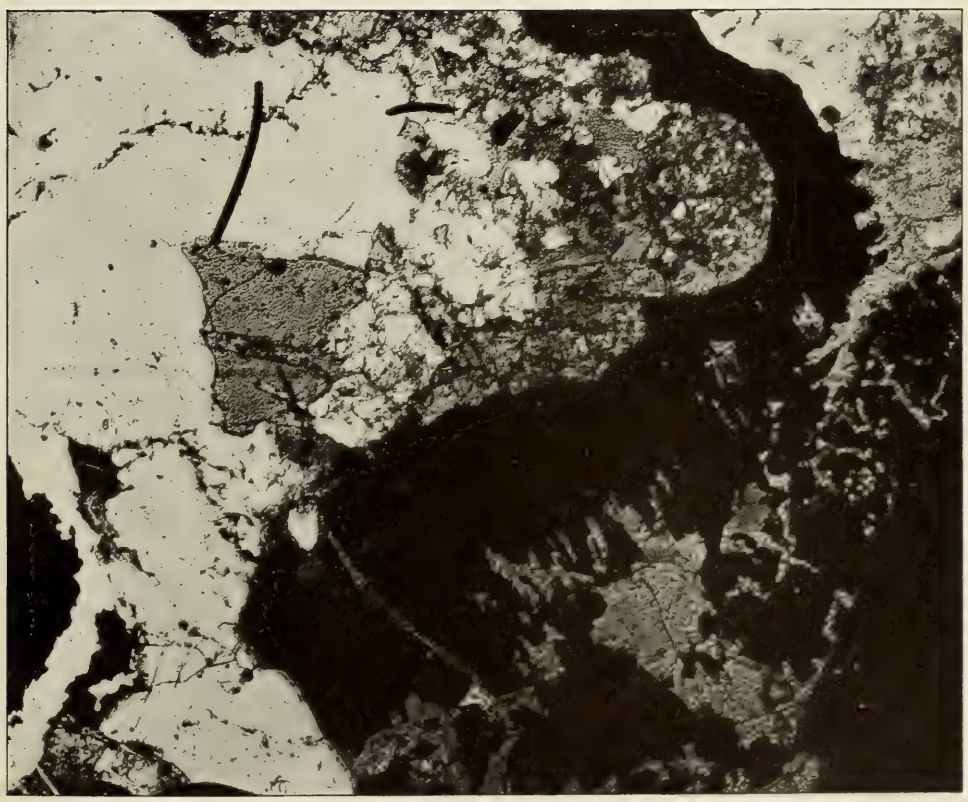


Fig. 23 Photomicrograph of pyritiferous pegmatite from foot-wall, Stella mine. Skeletal growth of pyrite in chlorite, which latter has developed chiefly at the expense of feldspar. (Magnified 27.5 diameters)

abundance of deep green chlorite which forms from both feldspar and hornblende but, so far as the evidence of a single section may be trusted, more from the former than the latter. This chlorite is fibrous and of a strong, deep green color persisting with crossed nicols which bring out aggregate polarization and weak double refraction. Pyrite in large masses is abundant, lying imbedded almost exclusively in the chlorite and molded upon hornblende and apatite instead of replacing them (see figure 24). The pyrite is frequently in slender branching aggregates which have grown in and been supported by the chlorite, and is clearly younger than the latter mineral.

As bearing upon the mobility of the chlorite, referred to in connection with previous sections, an interesting fact appears in this slide. At one point a very narrow crack has developed in a grain of pyrite, crossed an area of chlorite, torn it away from another grain of pyrite, and separated a corner of the latter. The crack throughout its course is sharply defined by narrow black boundaries and is completely filled with a later deposit of chlorite. The latter is the same deep green as the old chlorite and in ordinary light would not be distinguished from it but for the dark boundaries of the crack. With crossed nicols, however, the younger chlorite in the crack shows different optical orientation and so is sharply distinguished from the older mineral (see figure 25).

With this diagrammatic case before us it is easy to find many similar though less clear instances, and it becomes evident, as suggested previously, that the chlorite is very mobile, circulating relatively freely and thus tending to fill all spaces, however minute, in the rock. It is also clear that the several cases previously described where there seemed to be conflicting evidence as to the relative age of pyrite and chlorite are cleared up by this proof of at least two periods of chlorite formation, one before, the other after, the deposition of pyrite. As to the larger question of the date of pyrite concentration compared with that of the possible intrustion of the hornblendic rocks, an indication is given by the presence of clearly later pyrite masses in these rocks. That the same later date holds good for the larger ore bodies is probable, and this may account for the fact, already stated, that the ore deposits show no marked difference when compared with those not directly associated with similar rocks, but on the contrary agree in all essential features with the prevailing type as developed in the midst of extensive belts of Grenville sediments.

THE MINES AT PYRITES

At Pyrites, formerly called High Falls, pyrite was mined on a fairly large scale several years ago, but when visited by the writer the mines were idle and evidently had been so for some time. The locality is however of much interest and, standing alone, would be apt to lead to views quite unlike those presented in the sequel as to the origin of the ore bodies. Extensive exposures are afforded by the deep gorge of the Grasse river, at the lower end of which the pyrite is shown better than at any other locality visited. At this point a fine section is shown, the rusty gneiss being very strongly developed, dipping northwest at a high angle and striking northeast to north. A marked lens of pyrite about eight feet thick occurs in the gneiss, and the latter is itself permeated with pyrite. This lens with somewhat varying thickness extends to the top of a precipitous bank, but in the floor of the gorge pinches out abruptly along the strike. Veinlets of pyrite cut all the rocks including the ore lens itself, showing a certain amount of circulation late in the history of the formation, probably subsequent to all pronounced mechanical disturbance.

The rusty gneiss shows its usual contortions and abrupt changes of strike and dip, is strongly banded and foliated, and in every way appears to be sedimentary or, if igneous, is of extreme antiquity and has suffered most intense metamorphism with resultant obliteration of all original characters.

Immediately underlying the gneiss, with apparently conformable contact, is a rather massive, coarse, micaceous, nearly black rock, which is shown by exposures farther up stream to be a phase of the coarse gabbro so strikingly developed in the gorge above. While this rock is unquestionably later than the rusty gneiss, the contact between the two gives no suggestion of being an eruptive one, a fact difficult to explain (unless faulting be appealed to) but quite frequent in contacts between Grenville and later intrusive rocks throughout the region. The only thing suggesting the relations of the two rocks is the abnormal character of the gabbro at the contact as compared with exposures farther up stream, more in the heart of the intrusions. There is a decided contrast between the two rocks, but the character of that at the contact, though rather finer, is not such as to point clearly to contact modification. Thus, without the evidence afforded by other exposures, neither the nature

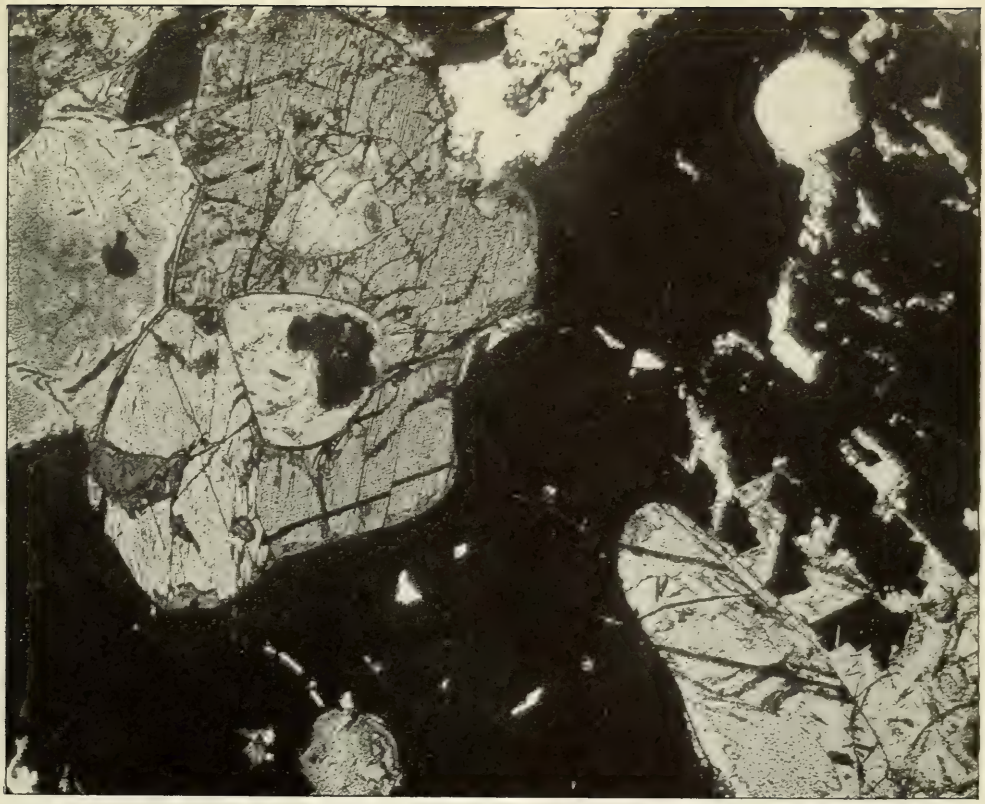


Fig. 24 Photomicrograph of pyritiferous hornblende gneiss, south of Anna shaft, Stella mine, with pyrite grown freely in chlorite, but molded upon hornblende and apatite. (Magnified 27.5 diameters)

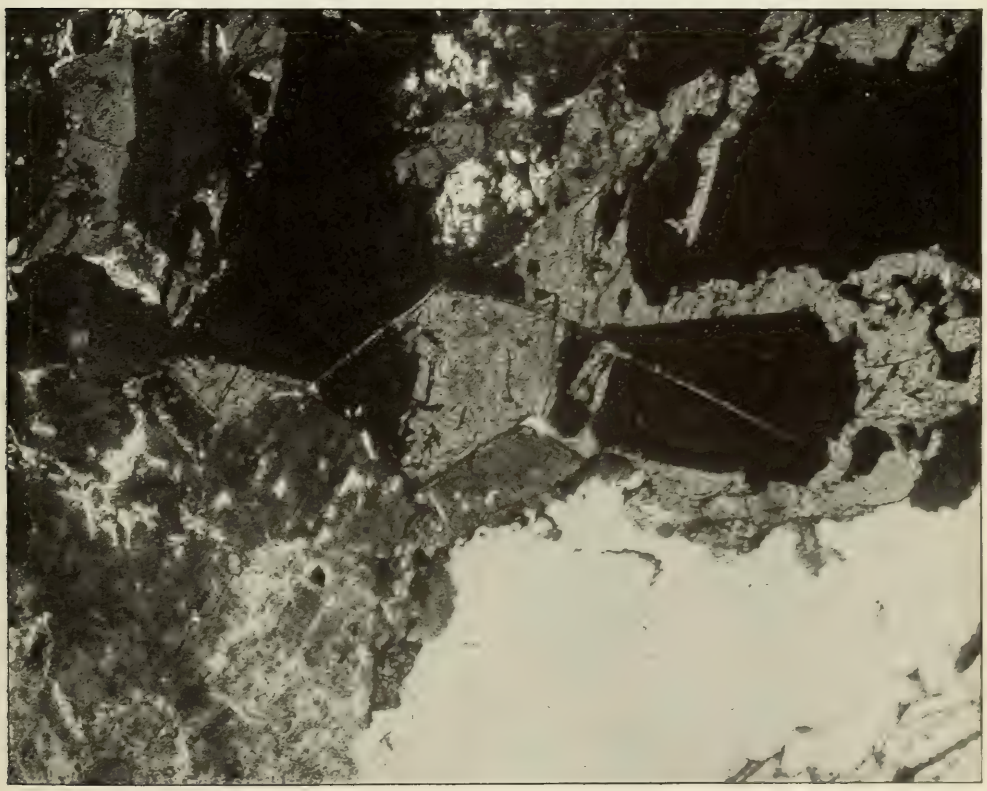


Fig. 25 Photomicrograph of pyritiferous hornblende gneiss, south of Anna shaft, Stella mine, showing pyrite developed in chlorite, with a crack passing through both, and filled with younger chlorite. (Magnified 27.5 diameters)

of the gabbro nor its relation to the rusty gneiss could be determined at this point. The section is diagrammatically shown in figure 26.

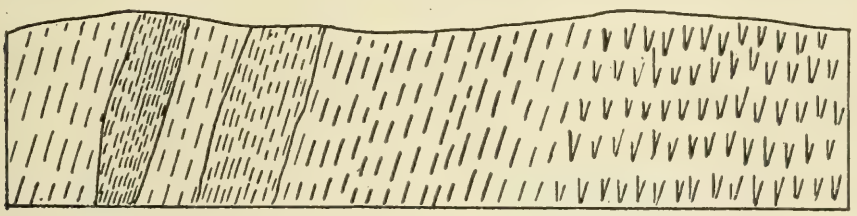


Fig. 26 Ore lenses more heavily shaded; gabbro hachured

A massive rusty gneiss with much pyrite, which might be classed as a second, but much lower grade ore body, underlies the main lens, with a small barren space intervening. As indicated in the diagram, it is thicker than the main lens, and much less sharply defined, while at the same time the pyrite is very unevenly distributed.

The gabbro above referred to is by far the most conspicuous rock of the section and is best shown at the paper mill about half a mile upstream from the first mentioned locality. The rock is very dark in color, sometimes almost black, varying from medium to very coarse in grain and from massive to strongly foliated. Abundant mica, with a suggestion of flattened orbicular structure, gives to some exposures a most peculiar aspect quite unlike that of any rock seen by the writer elsewhere in the northern Adirondack region. Farther upstream the rock becomes a rather coarse hornblende gneiss whose origin would be very obscure but for the fortunate exposure of the transitional belt between the two phases.

While in the field the rock is conspicuously hornblendic and micaceous rather than pyroxenic, thin sections of the more massive varieties show sufficient pyroxene to indicate the probability that this was the prevailing original ferro-magnesian mineral. For this reason the rock is regarded as a member of the widespread gabbros of the Adirondacks, rather than a somewhat pyroxenic diorite. The gabbro, in its gneissoid phase, is extensively developed in the vicinity and, while not yet mapped, covers some square miles. A considerable extension to the southwestward toward the Stella mines tends to support the conclusion, previously referred to, that the very similar hornblende gneiss at the latter locality may be in reality a phase of this same gabbro.

While at the lower end of the gorge at Pyrites the gabbro appears below the ore only, south of the paper mill it occurs also as a thin sheet above the pyrite formation, the main body continuing below. This is best shown at the lower end of a small island in the Grasse river just below the dam. Here the rusty gneiss, with abundant

pyrite, is exposed in the river bed with a width of about forty feet; on the east (below) is the main body of gabbro, while at the west (above) the same rock appears and continues to the west bank of the river where gray gneiss of Grenville aspect comes in. The accompanying diagram (figure 27) makes these relations clear. At the upper contact of pyrite and gabbro, and in the former, is a conspicuous pegmatite containing tourmalin, garnet in large and fine crystals, and much pyrite. At the upper end of the island a few rods distant, the gabbro is continuous where the pyrite formation should occur, the latter having been cut out by the intrusion of the former. This explanation of the absence of the pyrite formation is justified by the fact that unbroken outcrops on both sides of the island eliminate the possibility of an abrupt change of strike and at the same time render faulting improbable.

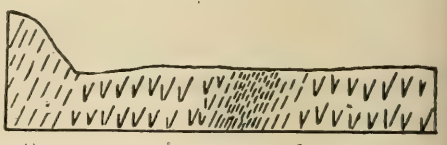


Fig. 27 Rus., gneiss and ore heavily shaded; gabbro cross hachured

From the foregoing description it is evident that the general impression given by Pyrites is very different from that afforded by the other pyrite localities. Instead of extensive outcrops of Grenville, with the conspicuous rusty gneisses, the great development of nearly black gabbro is the impressive feature; and in view of the general association of sulfid concentrations with gabbro, such an explanation is immediately suggested for the present case. Further support is given to this idea by the fact reported by Brinsmade[1] that a large body of pyrrhotite is associated with the pyrite in the mines.

The occurrence of the sulfids at the margin of an extensive intrusion of gabbro is certainly most suggestive of their concentration by magmatic differentiation while, assuming the hornblende gneiss at Stella mines to be part of the gabbro, a closely related method of origin might be inferred for the ore bodies of the latter locality. While much may be said in favor of this view, the writer is unable to accept it since, in spite of their intimate association with the gabbro, the ores at Pyrites actually occur as elsewhere in typical rusty gneisses, quite indistinguishable from those in which they occur at localities where gabbro is absent. For example, the exposures at the lower end of the Pyrites gorge shows rocks in every way similar to those at the Cole, Farr, Styles and other similar localities, while at the two shafts worked in recent years the material on the dumps can not be distinguished from that at other

[1] Brinsmade, R. B. Pyrite Mining in St Lawrence County, New York. Eng. and Min. Jour. Oct. 28, 1905, p. 770–71.

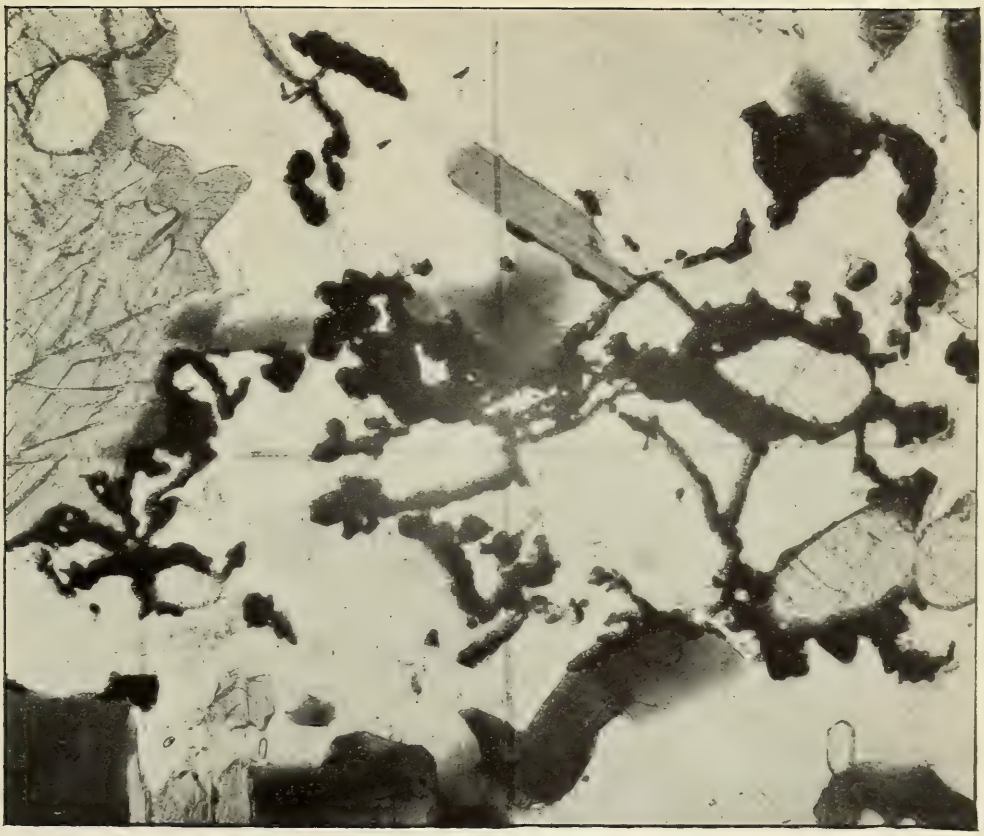


Fig. 28 Photomicrograph of gabbro associated with the ore at pyrites, showing an infiltration of pyrite replacing feldspar. (Magnified 83.5 diameters)

Fig. 29 Photomicrograph of lean ore, pyrites, showing pyrite replacing a single grain of plagioclase feldspar. (Magnified 83.5 diameters)

mines. Even where, at the lower end of the island, the pyrite has gabbro on both sides, the ore still occurs in the strongly laminated rusty gneiss rather than in the gabbro itself. As a matter of fact, very little pyrite occurs in definitely recognizable gabbro, and when present at all appears plainly to be a secondary infiltration, as illustrated by figure 28.

For these reasons, together with others to be mentioned later, it seems to be a necessary conclusion that the ore is not, even when closely associated with gabbro, a direct product of magmatic differentiation. On the other hand it is possible that solutions and vapors given off from the gabbro magma may have played a part in forming the ore deposits, although no positive evidence bearing upon the question is at present available and its further consideration is, therefore, best deferred till more extended data can be obtained.

A specimen of ore from the bed of the river consists of a very fine-grained, dark green, chloritic aggregate, with abundant graphite and rather evenly disseminated, irregular masses of pyrite. The thin section shows a quartz-feldspar-mica aggregate, with kataclastic structure, containing an abundance of graphite, light green chlorite and pyrite. The pyrite shows some skeletal structure with interspaces filled with chlorite. Though in itself of somewhat doubtful nature, the section closely resembles several from other localities which were, from the evidence given by the intermediate stages, regarded as formed by the alteration and replacement of Grenville mica gneisses. The dark color of the hand specimen might suggest a pyritiferous phase of the gabbro, but the microscope does not support this view and indicates that the color is due to the chlorite and the graphite. Another and very similar specimen, though almost as dark in color, is shown in a thin section to be very quartzose, but at the same time exceedingly rich in graphite together with a good deal of deep green chlorite. The quartz is much crushed and the chlorite has replaced it largely. The pyrite, in fairly large masses, shows few fractures and must have been deposited or recrystallized subsequent to the crushing. The original rock appears to have been a quartz schist.

A specimen from the dump differs from the above in being coarser grained and lighter colored, showing much quartz and mica and little graphite. Pyrite is abundant, evenly distributed and often in distinct crystals. The thin section shows very large areas of pyrite, green chlorite and bleached mica. The pyrite is somewhat cracked and recemented by secondary quartz. Indeed, it is quite possible that all of the quartz is of this origin. A single grain of plagioclase

shows a replacing network of pyrite (figure 29). Graphite is less abundant than in the preceding sections. By itself this rock is too much changed to show its origin, but comparison with others point to its probable derivation from a pegmatite or from a gneiss of the pyrite formation. The former origin is probable for a very coarse, quartzose ore from the dump with large masses of quartz probably of vein origin. The thin section shows a much altered quartz-feldspar-mica aggregate, with abundant fibrous yellowish chlorite and pyrite, a little graphite and garnet. Here the pyrite has often included small flakes of mica which, more or less altered, retain their outline very sharply. Graphite is not abundant.

A section of lean ore from the lower end of the gorge shows a quartzose gneiss with scattered grains of pyrite and the usual accompaniment of light green chloritic material. In this section there is little evidence of secondary introduction of pyrite and, standing by itself without reference to other examples, the pyrite would be regarded as, and probably is, a simple product of recrystallization during metamorphism. But instances of this kind are so uncommon as to make the prevalent relations of pyrite in the rocks more conspicuous.

It is clear from the above that microscopic study of the ores of this locality confirms the conclusion derived from field work that the pyrite can not be regarded as a product of differentiation in the gabbro magma. Between the two formations there is no close mineralogical relationship, while the ores agree in all essential respects with those of the other localities where gabbro is absent.

GENESIS OF THE DEPOSITS

From the foregoing brief statement as to field relations and microscopic character of the ore deposits, it is evident that the available data are inadequate to afford the basis of any complete explanation of their genesis. The many vicissitudes to which the pyrite-bearing formation has been subjected have lead to the obliteration of much evidence necessary to work out the successive steps in the process of pyrite concentration. Like the closely related "Fahlbands" and "Kieslager" of Europe, these ores belong to a complex class of deposits whose origin has always been a matter of doubt.

In dealing with such involved phenomena it is by no means easy to discriminate between the essential and the incidental, and yet there are certain features, common to all the pyrite occurrences studied, from which some certain definite conclusions and more or less probable inferences may be drawn as to the origin of the deposits.

Of these features perhaps the first that should be mentioned is

the distribution of the deposits, which has previously been referred to only incidentally.

When the pyrite localities are indicated on a map it is at once apparent that in a general way they conform to the prevailing northeast and southwest trend of the Grenville belts of the region, this trend corresponding approximately with the strike of the rocks. It should not be inferred, however, that the various mines occur along a straight line, for such is not the case, although the first four localities described do not vary widely from such an arrangement. This distribution of the deposits is the result of what may be taken as the second important feature to be mentioned, that is the constant association of the pyrite with Grenville rocks, which occur as long, narrow belts surrounded, and often broken across, by great areas of granite gneiss. This association of the pyrite with metamorphosed sediments rather than with the more extensive areas of igneous rocks, is a very striking feature of the deposits. Furthermore the association is not only with the Grenville but with a particular variety of the Grenville rocks, the so-called rusty gneisses, rocks which appear to be the products of metamorphism of impure sandstones and shales.

As to the possibility of the pyrite occurring not only in a certain kind of rock but in a certain definite horizon, a conclusion seems justified despite the dangers attending the use of ordinary methods of stratigraphy in dealing with the Grenville.

The Styles and Farr mines show such similarity of rock succession as to suggest the possibility of identity of horizons. The Hendricks pit, while showing limestone below the ore instead of having it above also, as these do, has a heavy thickness of gneiss. At the Cole mine scarcity of outcrops leaves relations uncertain, but this very scarcity indicates the absence of the heavy gneiss which overlies the ore at the Hendricks pit, though this latter locality is nearer the Cole than the others. At Stella the section is totally different in its details from all the preceding localities; the same is true of Pyrites, although here of course the great intrusion of gabbro would suffice to account for such dissimilarity. Combining these data, it seems necessary to conclude that the pyrite, though confined to a certain type of rock in the Grenville, is not limited to any definite horizon.

This occurrence of the pyrite in the one type of rock is another important feature of the deposit which must be considered in any hypothesis framed to account for its origin. In dealing with this phase of the problem there is a serious practical difficulty. All

rocks rich in pyrite weather with deep rusty brown and black stains, and very different rocks may, for this reason, be regarded as identical in the field. While fresh specimens often show differences at a glance, it is sometimes difficult to procure fresh specimens of such easily weathered rocks. Without having made any extended study of the so-called rusty gneisses, the writer has encountered two rather distinct types. One of these contains much pyroxene, hornblende, mica, feldspar, quartz, scapolite, a relatively large amount of titanite, some zircon, graphite and both pyrite and pyrrhotite. The minerals are often in rounded grains, and the rocks might be classed as pyroxene granulites. Though occurring in the Grenville, the origin of these rocks is obscure. Similar though more massive rocks, with much scapolite, have, as already stated, been classed as gabbros and were doubtfully placed in this category by the writer.

The rusty gneisses of the second type are of much simpler composition, having the ordinary minerals of acid gneisses together with graphite and pyrite, with interlocking crystalline texture. From the previous descriptions of the pyrite deposits it is obvious that they all occur in gneisses of the latter type, being portions of the rock exceptionally rich in pyrite. True, considerable variation of composition appears in the gneisses as described, but not enough to throw them into markedly distinct types nor any more than would appear in descriptions of an equal number of specimens of the ordinary Grenville gneisses. Perhaps the most pronounced peculiarity of the pyritiferous gneisses, particularly as contrasted with the pyroxenic rusty gneisses mentioned above, is their acidity, they being always very quartzose and in general lacking the minerals characteristic of basic gneisses. Even garnet and sillimanite, which might be expected in these metamorphosed sediments, are by no means common.

While it is true that the pyrite ore bodies are confined to this type of gneisses, it must not be forgotten that pegmatites present in the rocks also contain the mineral. The presence of these pegmatites is, moreover, one of the striking features of the deposits, for at no locality are they lacking. Whether or not they are more abundant in connection with the ore deposits than throughout the region as a whole, it would be difficult to say, but certainly they are no more abundant than at many points where no pyrite occurs. The pegmatite is often injected in thin layers parallel to the banding of the gneiss and so thoroughly blended with the latter as to make it

difficult or impossible to draw any line between the original and the injected material. The pegmatites themselves are derivatives of the great intrusions of granite-gneiss referred to above as surrounding and cutting through the Grenville, injecting it with every variety of intrusion from batholyths down to sheets of almost microscopic thinness. As shown in an early report,[1] where the intrusions become very thin they nearly always assume a pegmatic habit. This apparently anomalous behavior doubtless finds its explanation in the fact that only the more fluid portions strained off from the magma are capable of penetrating the narrow openings where, in virtue of their abundant gases and mineralizers, they naturally crystallize as pegmatites. It does not of course follow that no thick masses of pegmatite are present, since these are by no means rare, both types occurring with the ores.

It is hardly necessary to recall at this point the fact that the Grenville rocks are all completely metamorphosed by the combined action of orographic disturbances and igneous intrusions, under heavy cover. The tendency of the pyrite to occur as lenses, conforming in general with the prevailing dip and strike of the associated gneisses, in so far as it is the result of mechanical forces, rather than replacement of lense-shaped masses, is doubtless to be referred to disturbances subsequent to the period of intense metamorphism.

Among the more intimate features of the ore deposits mention should be made of the very general association of graphite with the pyrite, the former mineral occurring at all the mines, often in abundance though not evenly distributed through the ores. Thus while pyrite ores commonly carry graphite, this is not invariably the case. Conversely graphite, which is widespread in Grenville rocks, often occurs without pyrite.

Another feature of the ores is the nearly universal occurrence of a chloritic alteration product with the pyrite. This material is evidently derived from mica in some cases, but in others seems equally clearly to grow at the expense of other minerals, particularly quartz and feldspar. Such an alteration is by no means general in the Grenville rocks, but on the contrary appears to be the result of unusually potent chemical agents associated with the formation of pyrite.

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[1] Smyth, C. H., Jr. Report on the Crystalline Rocks of St Lawrence County. N.Y. State Museum, 49th Ann. Rept. for 1895, II, p. 491.

Finally, of the intimate features of the deposits, the most important is the relation which the pyrite bears to the other minerals present. So much has already been said upon this point that a brief summary will suffice here. While often occurring in rounded or irregular grains, whose relations to the other minerals are susceptible of various interpretations, the pyrite also frequently appears in shreds, strings and veinlets cutting the other minerals in such a way as to make evident that it is actually replacing them. There is a strong tendency for pyrite to develop its own crystal form quite independently of the surrounding minerals, and from cases of this kind there is every gradation up to large bunches of pyrite replacing the country rock. Such bunches occur scattered through the rock, united by strings and veinlets of pyrite, and as they increase in size and numbers gradually convert the rock into an ore. Associated with this replacement there is often the great development of chlorite referred to above, so that the ore becomes, as at Stella, a granular aggregate of pyrite and chlorite, the other minerals still present, with the exception of graphite, being pretty well masked by these two.

The time relation between pyrite and chlorite is not simple. As previously stated, pyrite often seems to crystallize more readily in contact with chlorite than with other minerals, suggesting that the chlorite was present first; but on the other hand chlorite sometimes fills cracks in pyrite and is therefore younger. However, this is a subsidiary phenomenon since the same chlorite fills cracks in an older chlorite, so that these cases prove nothing beyond the mobility of the mineral. The evidence as a whole indicates that, while closely related in time and origin, the pyrite is generally somewhat younger than the chlorite. Much less frequent, but not to be overlooked, is the development of sericite so related to chlorite and pyrite as to show that it is younger than these minerals.

To formulate a hypothesis that will unite and explain these various phenomena and at the same time harmonize with what is known to be true or probable in regard to the geology of the region, is by no means easy. Unquestionably the series of operations by which the ore deposits have been formed was exceedingly complex, the available data are meager, and the best that can be hoped is to get some clue to the more important agents involved.

Assuming the rusty gneisses to be of sedimentary origin, representing shales and impure sandstones deposited in the Grenville sea, a simple explanation of the pyrite is to regard it as a primary

chemical sediment deposited on the sea bottom, and thus originally interbedded with the other Grenville rocks. This would account for the association of pyrite with the gneisses rather than with crystalline limestones, in agreement with the familiar tendency of the mineral to appear in shales and sandstones rather than limestones. Furthermore the tendency in later rocks, as well as in modern muds, for pyrite to occur in such as are rich in organic matter, finds in the present instance a parallel in the association of pyrite with graphite. This association is quite general for the rusty gneisses and is very striking at the Cole and Stella mines, as already pointed out. Altogether, a consistent explanation of the rusty gneisses and accompanying pyrite seems, at first sight, to be afforded by regarding them simply as metamorphosed pyritiferous and carbonaceous shales and sandstones.

From an explanation so seductively simple it is difficult to turn, and the writer is of the opinion that, with present evidence, there is much in favor of this view so far as the ordinary rusty gneisses with a little disseminated pyrite are concerned. But in applying the hypothesis to the larger masses represented in the ore deposits, difficulties arise. Here we come in contact with marked concentrations of pyrite, in veinlike masses, pods and lenses, often very thick, with much vein quartz and pegmatite containing both pyrite and graphite, the whole presenting little resemblance to sedimentary deposits. Obviously some of these phenomena are entirely outside the realm of sedimentary agencies and there appears to be ample ground for ascribing most of this pronounced concentration to a later period of circulation, involving a large amount of transfer of material and replacement.

In view of the well-known tendency of pyrite to circulate and seggregate in sedimentary rocks subjected to the action of ordinary ground waters it is quite possible that the process of concentration was begun in this way before the rocks were metamorphosed, and Newland[1] regards such premetamorphic concentration as probably of dominant importance. The complete recrystallization of metamorphism would, of course, destroy all the original structural relations between pyrite and the clastic minerals which would show whether the former was original or secondary, and thus after metamorphism it would be impossible to distinguish with certainty between pyrite of sedimentary origin and that resulting from ground water concentration, except as the latter might occur in

[1] Loc. cit.

masses of such form and magnitude as to be difficult to reconcile with a sedimentary origin, as is true in the present instance. Thus it is entirely possible that pyrite deposits might be formed by both of these processes, and be quite indistinguishable after metamorphism sufficiently intense to involve complete recrystallization.

That any considerable concentration of pyrite was effected by the metamorphism is improbable. The process doubtless resulted in a crystallization of the minerals already present in the rocks with no decided change of ultimate chemical composition. Original pyrite would be recrystallized, and where the proper materials and conditions existed, new pyrite would be formed, just as other minerals were formed throughout the whole mass of rocks from materials already present. All of this pyrite, both recrystallized and newly formed, would bear to the other minerals of the metamorphic rocks relations similar to those which these latter bear to each other. In other words, the pyrite would appear as a perfectly normal and essential constituent of the rock, taking part in its regular crystalline texture. Some of the thin sections examined show this relation, and doubtless if many sections of gneiss with scattered grains of pyrite were examined the relation would be found to be quite general. But from the descriptions of sections of the ores already given, it is quite apparent that in these most of the pyrite bears a very different relation to the metamorphic minerals, indicating its deposition as being subsequent to, rather than simultaneous with, their formation. In so far as this is the case it is evident that the ores are neither original sediments nor premetamorphic replacements; and there is much evidence justifying this conclusion. In particular, the widespread chloritic alteration of the gneisses associated with the ore deposits, the very close connection between this alteration product and the pyrite, the late deposition of the latter mineral, so evident in many cases, replacing the minerals produced by the general metamorphism and often crystallizing in the chlorite secondary after these, the frequent abundance of vein quartz as a gangue, and the presence, in many cases, of pegmatite containing much pyrite replacing the primary minerals, are all phenomena, any one of which might perhaps be reconciled with the hypothesis of original sedimentation or of premetamorphic replacement, but in mass weigh heavily against them. Whatever the original source of the pyrite, these phenomena point to its relatively late concentration, subsequent to the period of extreme metamorphism.

If this conclusion is justified it follows that the ore bodies were

formed by the action of circulating solutions, which either concentrated into large masses, pyrite already present in a disseminated condition in the rocks, or introduced the mineral from an outside source. Manifestly these two sources of pyrite are in no way antagonistic and may both be of importance. Nor is it necessary to suppose that the pyrite is derived directly from iron sulfid of either origin, since it may, in part or wholly, result from reactions converting totally different compounds into sulfid.

All of the phenomena point to conditions quite different from those prevailing during metamorphism, involving the destruction of metamorphic minerals, but still, doubtless at such depth as to give temperatures and pressures considerably above those at the surface, and with circulating hot water, either magmatic or meteoric, as the active transporting agent. Between these two sources of the solutions there is no way of deciding finally, since solutions of either origin would probably be capable of effecting all the changes observed in connection with ore formation. Of minerals pointing certainly to igneous sources, only tourmalin is frequent in the ores, and this antedates much of the pyrite. Still, the mineral alterations in the rocks and ores are such as to suggest, strongly, the work of magmatic waters and, this being the case, with igneous intrusions so abundant throughout the region it is probable that magmatic solutions played a major part in the processes of ore concentration.

A formation that has been so thoroughly injected by igneous rocks and soaked by magmatic solutions and vapors might naturally be expected to show much concentration of metaliferous materials, and the probable explanation of their comparative scarcity is to be found in the fact that the existing surface rocks were, at the time of these activities under heavy cover, up into which the more mobile elements were carried to be subsequently removed by erosion, leaving the more abundant and stable substances, chiefly iron compounds, in the deeper regions now exposed. In so far as the pyrite is of sedimentary origin, it is probable that its migration and concentration may have been in part due to these magmatic agencies which must have permeated the Grenville rocks during prolonged periods. At the same time there may have been a contribution of pyrite derived from magmatic sources. In the field there seemed to be strong evidence for this latter view in the general occurrence of pyritiferous pegmatites associated with the ores, and it was thought that these might be regarded as important bearers of pyrite,

perhaps indeed the chief source. But, as already stated, microscopic study shows that the pyrite of these rocks replaces the other minerals, particularly the feldspar, and thus is secondary.

While it is evident therefore that the pegmatites are not the direct source of the pyrite, there is much reason for believing that their association with the ore deposits and their presence throughout the Grenville in such abundance, as well as the other evidences of extreme igneous activity point to magmatic sources for ore-forming solutions. Magmatic emanations permeating the gneisses would certainly appear to be the most probable agents to bring about the deposition of pyrite, replacing the older and usually very stable minerals.

The absence of contact and fumarole minerals approximately contemporaneous with the pyrite indicates that the latter was formed late in the history of igneous activity, when instead of the very potent fluorine, boron and chlorine compounds, hydrogen sulfid which marks a declining stage of igneous activity, was the dominant agent. Thus the pyrite probably was deposited after active intrusion of the magmas, from which it was indirectly derived, had ceased, and during a prolonged period of relatively gentle circulation of magmatic waters. To these agencies may be ascribed not only the deposition of pyrite but the closely associated formation of the peculiar chloritic alteration product, which is so characteristic of the ore deposits and of the less abundant sericite.

It is evident that magmatic agencies might operate in two ways to bring about the observed results, namely by concentrating pyrite already present in a disseminated condition, and by introducing entirely new pyrite of magmatic origin. These two processes would work together and combine to build the ore deposits. But it is probable that an intermediate operation may also have been effective, one constituent of the pyrite, iron, being already present as an original constituent in the rock, and the other, sulfur, supplied by the magma. Bleaching of the mica is a characteristic feature of the conversion of gneisses into ores, indicating the removal of iron from this constituent. Some of this iron reappears in the chlorite, but the latter is itself nearly always of a conspicuously pale tint, indicating low iron.

While the elaborate series of analyses needed definitely to establish the fact is lacking, it appears to be true that most of the iron originally present in the essential minerals of the gneiss, is now combined with sulfur to form pyrite in the ores, and if the pyrite

were entirely removed the residue would be much lower in iron than was the original rock. While mica is the only mineral to which the iron of pyrite can be definitely traced, it is quite probable that other iron compounds, such as garnet, magnetite and amphibole may have been sources of the metal which have undergone complete decomposition. It is an interesting fact that no magnetite has been noted in any thin sections, suggesting its complete conversion into pyrite.

This introduction of magmatic H_2S is thought to have been a potent agency in the production of the ores, but obviously the mere conversion by this agent of original iron into pyrite could not produce the ore bodies unless the original rock was very rich in iron compounds. That such may have been the case is entirely possible, and this may account for the localization of the ore deposits. But it is much more probable that the circulation that introduced the H_2S, with consequent formations of pyrite, also effected a concentration of this mineral with the consequent formation of the existing ore deposits.

In this connection there naturally arises the question as to why the pyrite, if not a primary precipitate, should be confined to a certain phase of the sedimentary formation, and this not the most soluble or easily replaced phase. One reason for this doubtless is, as just suggested, that magmatic sources supplied the sulfur of pyrite, the iron being an original constituent of the sediments. On this assumption the ore deposits would necessarily form in the gneisses derived from the shales and sandstones, which would be the iron-bearing members of the sedimentary formation, rather than the limestones. All other conditions being the same, and H_2S circulating through limestones to the same degree as through the metamorphosed shales and sandstones, there can be little doubt that any pyrite thus formed would be chiefly confined to the latter rocks for the simple reason that they alone would contain the iron necessary to combine with the sulfur to form pyrite. Pyrite so formed together with such original pyrite as may have been present, would tend to cause precipitation and further concentration in these rocks of pyritic materials of wholly extraneous origin, brought in by the circulating solutions. In this way the magma might furnish not only sulfur but iron as well.

While the concentration of pyrite in the gneisses rather than in the more soluble and chemically active limestones is thought to have been effected partly in this way, other factors have doubtless worked in the same direction. As already stated, the folding of the Gren-

ville took place in part under such conditions of load that the limestones and the gneisses behaved very differently, the former flowing like putty, while the latter were often greatly fractured. Doubtless this fracturing came at a time subsequent to the general metamorphism of the rocks, with decreased cover; and as it is under these conditions that the ore deposits are thought to have formed, it follows that the active solutions would have found much readier channels of circulation in the fractured gneisses than in the soft and putty-like limestones. This is regarded as an important, if not the chief, cause of the localization of ore deposits in the gneisses.

That the two types of rocks in question actually did afford such different conditions affecting circulation is clearly indicated by their relations to intrusions of the magma itself, and particularly such portions of the latter as are most closely related to magmatic solutions. On the one hand, as before stated, the gneisses and schists are repeatedly converted into injection gneisses, soaked through and through by granitic material often with highly developed *lit-par-lit* structure. Such injected material is often very acid, and pegmatitic on a small scale, and the sheets may be exceedingly thin. In other cases the gneiss is reduced to tiny fragments entirely surrounded by injected material. All the phenomena point to a very high degree of fluidity in the injected magma, approaching closely to the mechanical condition of the pyrite-forming solutions. In the limestones, on the other hand, such injection phenomena are rare, if they ever occur, all intrusions being comparatively massive in character. The contrast is striking and points clearly to the difference in the two types of rocks, as regards their reaction to pressure, as its cause. That the same effect would be produced upon the somewhat later circulation of magmatic waters forming the pyrite, is a natural and justifiable conclusion.

The possible function of graphite in the concentration of pyrite is a most obscure problem and its adequate treatment would greatly transcend the limits of this paper, involving as it does two distinct questions — the origin of the graphite, and its power to precipitate pyrite under the conditions present. As to the former question, in rocks of such antiquity affected by profound metamorphism and intense igneous activity, the writer would be more inclined to judge of the origin of the graphite from the nature of the rock containing it, than to regard the rock as sedimentary because it carries graphite of supposed organic origin. In the present instance, the pyritiferous formation as a whole is for many reasons regarded as sedimentary

and the assumption of the organic origin of the generally disseminated graphite is therefore well grounded. Even when graphite occurs in the pegmatites it may perhaps have been absorbed from sediments through which the pegmatites have passed. However, where graphite occurs in igneous rocks, the writer feels that the burden of proof rests with those who claim for it an organic, rather than a magmatic, origin. Doubtless most if not all of the carbon of sediments is ultimately of magmatic origin, and while it may become reincorporated in igneous rocks after passing through the atmospheric and organic stages, no reason is apparent why it may not also remain in the magma to appear not only in the compounds liberated by heat in the laboratory but as primary graphite. Many instances[1] are on record where no other source seems probable. But where, as in the present case, relatively small intrusions, carrying graphite, cut sediments in which this mineral is quite generally disseminated, absorption of graphite by the intrusions seems reasonable. Such absorption, however, implies mobility on the part of the graphite that might lead to considerable circulation and concentration, and raises the question whether the graphite, so abundant in some of the ores, was actually formed *in situ* by metamorphism of organic matter, or is in part or wholly a product of secondary concentration. So far as some of the ores are replaced pegmatites, this question does not of course arise, since any graphite present in these rocks must, if of organic origin, be a secondary introduction; but in the ordinary ores formed from gneisses it is of moment. Thin sections give no positive information on the matter, although in several instances some of the graphite appears to be younger than pyrite, implying the secondary introduction of the former. However, the evidence is capable of a different interpretation and thus not final. Vein quartz sometimes carries graphite and pyrite so related that their late and practically contemporaneous origin seems necessary. This shows that circulation of graphite has occurred in connection with the formation of ores, and it is probable that this circulation has resulted in con-

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[1] Weinschenk, E. Mémoire sur l'histoire du graphite. Compt. rend., VIII Congr. Géol. Internat., 1900, Paris 1901, p. 447.

Clarke, F. W. Data of Geochemistry, Bul. 330 U. S. Geol. Survey 1911, p. 311.

Winchell, A. N. Theory for the Origin of Graphite, etc., Ec. Geol. VI, 1911, p. 228.

Horwood, C. B. The Mode of Occurrence and Genesis of the Carbon in the Rand-Bankets. Trans. Geol. Soc. South Africa, 13, 1911, p. 65–92.

centration of graphite as well as of pyrite. In this connection, much interest attaches to Young's recent conclusion[1] that the graphitic carbon, relatively abundant in a few of the mines in the Rand conglomerates, is not of organic origin but is derived directly from magmatic vapors. Young is dealing with conditions which are similar to those that must have prevailed in the Grenville rocks prior to the period of intense metamorphism when a certain amount of concentration of pyrite may have occurred, as already indicated. Any magmatic carbon introduced at that time would evidently be indistinguishable now from carbon of organic origin, having been completely recrystallized by metamorphism. Thus, for the graphite, a history somewhat similar to that of the pyrite is indicated, but with the difference that most of the former is thought to be carbon that was original in the sediments, which has undergone some concentration and may have received minor additions from magmatic sources, while, in the case of the pyrite, the relative importance of these sources is reversed.

As to the relation of graphite to the precipitation of pyrite there can be no doubt that the original organic matter, from which the graphite was formed, was a potent agent both during sedimentation and any subsequent ground water concentration of pyrite. In the postmetamorphic stage, to which the main concentration of pyrite is ascribed, any precipitating effect would be due of course not to organic matter but to graphite. The oft-quoted instance of such precipitating action of graphite at Freiberg described by Von Cotta[2] has been supplemented by many other cases, and recently Jenny[3] has cited several examples. On theoretical grounds the action can be regarded only as a question of pressures and temperatures, and with these properly adjusted there can be no doubt that graphite would act as a precipitating agent. But so little is known, on the one hand, as to what pressures and temperatures would permit the necessary reactions and, on the other, as to the pressures and temperatures under which the pyrite was formed that little is to be hoped for in the present case from these general theoretical considerations. But with such a precipitating action possible, the marked association of graphite with the pyrite is, to say the least, very suggestive, and the former being regarded as representing a

[1] Young, C. R. Trans. Geol. Soc. South Africa, XIII, 1911, p. 105–6.

[2] Von Cotta. Treatise on Ore Deposits, English Trans., p. 46–47.

[3] Jenny, W. P. The Chemistry of Ore Deposition, Trans. Am. Inst. M. E. XXXIII, 1003, p. 455–57.

primary constituent of the sedimentary gneisses, another reason appears for the concentration of the pyrite in these particular rocks, they being rich in graphite. Even were the precipitating action limited to the original organic matter from which the graphite is derived a similar though less important effect would result, since the presence of premetamorphic pyrite would favor the later deposition of pyrite in the same rocks.

But while the relation of pyrite and graphite can hardly be considered as other than in some way genetic, the writer is not convinced that it is as simple as above suggested and feels that further investigation may prove that the graphite, like the pyrite, has a very complex history, the two minerals having grown, in part, simultaneously, but the development of the former beginning before and ending after that of the latter.

So far as the distribution of the pyrite deposits bears upon the suggested hypothesis as to their origin, the lack of knowledge of the areal geology of the region prevents any detailed discussion. While viewing the deposits as chiefly due to magmatic agencies, the explanation offered postulates no close association in space between the ores and the intrusive rocks. On the contrary, the phenomena are thought to point distinctly in the opposite direction, the deposits being conspicuously unlike those due to contact metamorphism. The fact that igneous rocks are generally distributed throughout the region, so that no point in the Grenville can be beyond the reach of solutions derived from these, affords the necessary basis for the explanation appealed to, and thus marked areal relations between ore deposits and intrusive rocks are not to be expected. The distribution of the deposits is therefore controlled primarily by the distribution of the Grenville, which explains their linear arrangement.

A secondary control by large structural features, such as faults and shear zones, is probable, but much further study of the whole region is needed before any decision upon this point can be reached.

With reference to the type of igneous rock with which the pyrite is to be regarded as genetically associated, a tentative conclusion is justified. The intimate association of the pyrite at Pyrites with gabbro and the possible occurrence of the same rock at Stella mines, together with the very general genetic connection between iron sulfids (though as a rule pyrrhotite rather than pyrite) with basic rocks strongly suggest such a connection in the present instance. But a serious difficulty stands in the way of the acceptance of this view.

The gabbro, though extensively developed in the region immediately surrounding Pyrites, and extending well over toward, if not to Stella, is not a common rock elsewhere in the region, and so far as known does not occur anywhere in the vicinity of the other pyrite deposits. If, therefore, the present knowledge of the areal geology of the region may be trusted, it seems necessary to conclude that the gabbro is quantitatively insufficient to explain the origin of the pyrite as a whole though perhaps of importance in the two localities named. On the other hand, granites, both massive and gneissoid, with pegmatitic and other modifications, are everywhere abundant, and if magmatic agencies play the rôle that has been assigned to them there can be no doubt that their source must be sought in the granitic reservoirs.

Not only is this conclusion demanded by the general distribution of the igneous rocks, but it is strongly indicated by the actual occurrence of pegmatites in all the ore deposits and also by the abundance of vein quartz similar to that often associated with the granite and pegmatites of the region. It is then in the granite magma that a source is found for the heated solutions rich in H_2S and doubtless containing other chemical reagents, and iron, and it is to the circulation of these solutions in the gneisses and schists that the concentration of the ore bodies as they now occur is ascribed. As before stated, however, deeply circulating meteoric waters would probably be capable of producing the phenomena observed. Igneous agencies are invoked on the general ground of their high efficiency and on the special ground of their abundance in the region as a whole and the constant presence of their products in association with the ore deposits.

The conditions under which the deposition of pyrite took place are regarded as, in essence, similar to those prevailing in the formation of fissure veins, in so far as these latter are replacements of the wall rock. In this connection much interest attaches to the following quotations from Lindgren's exceedingly valuable paper on "Metasomatic Processes in Fissure Veins."[1] "Of all the sulfids occuring as metasomatic minerals, pyrite is naturally the most common. The mineral has a remarkable tendency to crystallization when developing in the rock, as contrasted with its often massive texture when occurring as a filing of open spaces. The forms assumed are either cubes or pentagonal dodecahedrons, or a combination of both. Pyrite develops in nearly every one of the ordinary constituents of rocks. By

[1] Lindgren, W. Trans. Am. Inst. Min. Eng. 30, 1900, p. 578–692.

preference, it forms in the new aggregates of sericite, carbonates and chlorite so common in altered rocks; but it also occurs in the fresh original minerals of the rocks, as in quartz, feldspar, horneblende and pyroxene. It is common to find small, sharp crystals embedded, for instance, in perfectly clear quartz grains, which show no break in their optical orientation around the secondary crystal, proving that the genesis is by purely metasomatic processes, and not, as may be advocated in the case of crystallization in soft aggregates, by the mechanical pressure of the growing crystal" (page 615). "The pyrite crystals are often bordered by a small rim of calcite or quartz; and little bunches of sericitic fibers may adhere to them, when forming in quartz" (page 616). Of chlorite he says, "This mineral, replacing amphibole, pyroxene and biotite, is commonly found in altered vein-rocks, but ordinarily is only a transition form, often abnormally rich in iron, which these minerals assume under the influence of waters slightly charged with carbon dioxid before their final conversion into sericite and carbonates. The chloritic alteration is most important in the group of the propylitic veins. Under the influence of strong alkaline carbonates and carbon dioxid, chlorite can probably not exist" (page 610). Later he quotes Rosenbusch on the development of the propylitic facies involving "a considerable development of sulfids," and says, "The waters principally active during the formation of the propylitic veins probably contained only a small amount of carbon dioxid and very little lime, but may have been rich in sulfuretted hydrogen" (page 645). Finally, in summarizing he says, "I believe that the majority of fissure veins are genetically connected with bodies of intrusive rocks, even when the actual deposits are contained in overlying surface lavas" (page 691).

The descriptive portions of these passages might be applied with little change to the pyrite, chlorite and sericite of the deposits under consideration, and although propylitic alteration is a feature of surface flows, it seems to shed light upon the deeper seated operation here dealt with. In both cases waters heavily charged with H_2S are the active agent, and pyrite is an important product. The accompanying chlorite is considered by Lindgren to be unstable in the presence of much carbon dioxid, altering to sericite and carbonates. In the present case, deficiency of carbon dioxid doubtless accounts for the relative stability of the chlorite, although at one point, the Hendricks mine, the process has gone to completion, with the formation of sericite, calcite and quartz. Thus in the pyrite

deposits there are several essential features which closely resemble phenomena shown in the wall rocks of fissure veins, where they have suffered alteration as a result of the attack of the vein-forming solutions, derived generally from magmatic sources. Without putting too much stress upon the similarity of phenomena, it is regarded as giving additional support to the hypothesis here advanced.

But while presenting this interpretation of the observed facts as worthy of careful consideration, the writer wishes again to accentuate the great complexity of the region as a whole and the consequent obscurity of the particular problem in hand. To ascertain all the factors entering into such a complex problem and to give them their proper relative weight is a difficult task, and the writer is by no means sure that he has succeeded in the attempt. The evidences of relatively late circulation and crystallization of pyrite and the associated chlorite and sericite have perhaps been given too much prominence and should be regarded as minor phenomena. The very agencies to which such potency has been ascribed might as a result of this potency completely rearrange pyrite already present in the rocks and thus destroy the evidence of its early formation. This mobility of pyrite is a very serious difficulty in the whole problem.

In summing the matter up on the basis of present data, it appears to the writer that four periods of pyrite formation are probable: (1) A primary precipitation of pyrite contemporaneous with the formation of the sediments; (2) a concentration of this pyrite by circulating ground waters, with the addition, perhaps, of pyrite of deep-seated origin, before the period of metamorphism; (3) but of minor importance, a recrystallization of all pyrite, accompanied perhaps by a certain amount of formation of new pyrite during metamorphism; (4) a further development and concentration of pyrite by magmatic agencies, perhaps working in combination with ground waters, as outlined above, following the period of active igneous intrusion and metamorphism. The first of these periods is suggested by the pyrite so generally disseminated through Grenville rocks, although even this could of course, in view of the widely disseminated intrusions, result from the operations of the fourth period. The reasons for accepting the latter have been given at length, while the second period is purely hypothetical, being based merely on the marked tendency for disseminated pyrite to be concentrated by ground waters and the frequency with which the mineral is brought up from deep-seated sources. Nevertheless, though hypothetical, it is thought that this process is likely to have

led to more pronounced concentration than was effected by primary sedimentation. In both processes organic matter, the residue of which appears as graphite, would be an active agent. Deposits of either origin would of course during metamorphism undergo recrystallization, together with the other constituents of the sediments, accompanied by little if any concentration. Pyritiferous gneisses and schists would result, but obviously the pyrite would not bear to the other minerals the relations that it has been seen to bear in the ores. True enough, some sections, as already described, have pyrite that appears to be an essential part of the gneiss, and this is doubtless of the earlier origin and metamorphosed, but it is so rare that an extensive postmetamorphic recrystallization *in situ* is demanded unless much of the pyrite is, as here argued, of this later period of formation. Between the two hypotheses, the latter is deemed more probable.

While the suggestion of four periods of concentration of pyrite, under diverse conditions, may be thought to indicate a degree of complexity not demanded by the facts, and perhaps even improbable, it must be remembered that the ore deposits belong to a type that is essentially complex and occur in a region that is complex. These are facts to be reckoned with, and it is believed that no simple explanation will meet the existing situation. Indeed, the writer is convinced that what is here presented constitutes the barest outline of the actual series of processes involved in the genesis of the ores, a series which, if it could be worked out in complete detail, would doubtless afford a bewildering assemblage of phenomena.

Pyrite is a mineral capable of forming and existing under a great variety of conditions. Its constituents are abundant and circulate freely, favoring much diversity and complexity in methods of concentration. Granted the primary deposition of some pyrite in the original sediments (and such an assumption is conservative) the general geological relations of the region, together with the details of the ore bodies, point very clearly to the various stages of concentration stated, with the exception of the second, which is assumed on the grounds of probability based upon the known properties of pyrite as a rock constituent. In other words, some of the pyrite is regarded as probably of sedimentary origin, and must of course have passed through all the many and complex conditions to which the Grenville sediments have been subjected, involving its circulation in ground waters, recrystallization during metamorphism under conditions of stress, and finally another recrystallization under static

conditions, whether through the intervention of magmatic or of meteoric waters or both.

In view of the nature of pyrite, it is probable that the general tendency during these operations has been toward concentration rather than dissipation, and it is possible that workable deposits might result. But, as shown above, there is reason for believing that in the final stage at least, pyrite has been added from external sources.

While, on the assumption that the four periods of concentration are well established, there is still room for much difference of opinion as to their relative importance, from what has been said above it is evident that the writer regards original sedimentation as merely of potential importance affording only disseminated pyrite which would demand great concentration to be available. Such concentration may have been effected to a considerable degree in the hypothetical second or ground-water period, was probably not greatly influenced in the third or metamorphic period, and was chiefly accomplished in the fourth or postmetamorphic period, during which, minerals formed in the third or metamorphic period were broken down and replaced by others, of which pyrite is the most important. That much of the pyrite was actually deposited in its present form and place during this period is certain, that the ore bodies are to a large degree the products of this deposition is the conclusion reached from the evidence now available.

RECENT MINERAL OCCURRENCES IN NEW YORK CITY AND VICINITY

BY H. P. WHITLOCK

PYRITE FROM KINGSBRIDGE

Some interesting pyrite crystals from this locality were described in 1893 by Prof. A. J. Moses of Columbia University.[1] These crystals which are shown in figure 1 (reproduced from figure 1 of Professor Moses' paper), average 8–15 mm in diameter, and were found in a cavity in crystalline dolomitic limestone associated with dolomite, transparent green muscovite, quartz and some minute crystals of rutile. They show only the common forms *a* (100), *o*(111), *e*(210), *n*(211) and *s*(321). Professor Moses noted a marked tendency to striation in the zone [111. 210], as well as a somewhat less pronounced striation tendency in the zone [100. 111]. This would appear to be due to incipient development of the forms (211) and (321).

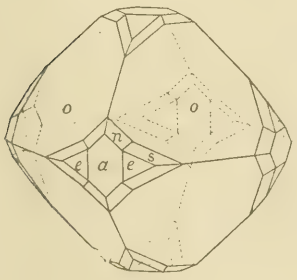

Fig. 1

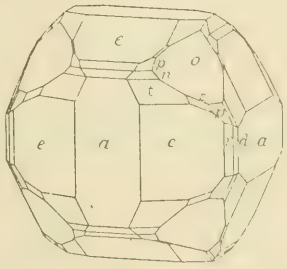

Fig. 2

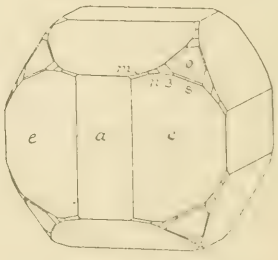

Fig. 3

The writer was recently enabled, through the courtesy of Mr James J. Manchester of New York and of the New York Mineralogical Club, to study several specimens from Kingsbridge, which proved to be of more complex crystallographic development than those described by Professor Moses.

The specimen loaned by Mr Manchester and which was collected by him during the past year consisted of a single small crystal measuring 3 mm in diameter and developed with almost diagrammatic symmetry. The faces which are sharp and brilliant gave excellent images of the signal. This crystal, which is illustrated in figure 2, shows besides the forms previously recorded from the locality the forms *d*(110), *g*(520), *v*(650), *p*(221) and *t*(421), all of which have

[1] A. J. Moses. Am. Jour. Sci. 1893, 45,488.

been frequently recorded for pyrite. The development of the zone [210. 001] is specially characteristic of this crystal, the forms occurring as follows: (210), (421), (211), (212), (213), (214), (001).

The forms occurring in the zone [001. 110] are: (001), (112), (111), (221), (110).

The forms were identified by means of their zonal positions as follows:

LETTER	ANGLE	NO.	MEASURED		CALCULATED	
Zone [100 . 110]						
a : g	100 : 520	2	21°	39′	21°	48′
: e	: 210	11	26	35	26	34
: o	: 650	8	39	44	39	48
Zone [210 . 001]						
c : t	210 : 421	8	12	36½	12	36
: n	: 211	13	24	3	24	6
: p	: 212	10	41	47	41	49
: s	: 213	6	53	19	53	18
: t''	: 214	6	60	48⅓	60	48
Zone [100 . 111]						
a : n	100 : 211	6	35	16	35	16
: p	: 122	5	15	46½	15	47½

The specimens loaned by the New York Mineralogical Club were collected several years ago by Dr George F. Kunz. The two loose crystals selected for study measured about 10 mm in diameter and were rather more distorted than the smaller crystal from the Manchester collection. These proved to be of a distinctly different type from either the Manchester crystal or those described by Moses. A crystal of this type is shown in figure 3 and an enlarged portion of the octahedral field in (figure 4.) Although for the most part the planes are well developed and brilliant, they show a greater tendency toward the formation of vicinal planes, particularly in the zone [100 . 111]. On one of the two crystals measured this tendency finds expression in the production of a vicinal prominence of the octahedral face. In addition to the forms noted by Moses the following were observed: $n(211)$, $m(311)$, $\beta(322)$, $\mathfrak{m}(522)$ and $\mathfrak{n}(755)$,

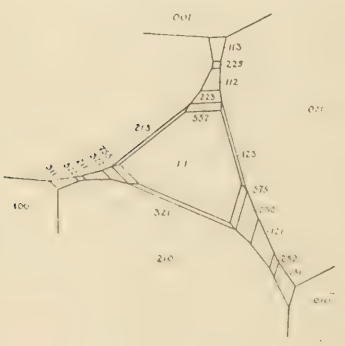

Fig. 4

the last being new to the species. The habit is more pyritohedral than either of the former types and the zone [100 . 111], although composed of small modifying planes, is rich in forms. The occurring forms were identified by their zonal positions as follows:

LETTER	ANGLE	NO.	MEASURED		CALCULATED	
Zone [100 . 111]						
$a : m$	100 : 311	14	25°	10⅓′	25°	14½′
: **m**	: 522	6	29	41	29	30
: n	: 211	8	35	15½	35	16
: β	: 322	7	43	18	43	19
: **n**	: 755	6	45	23	45	18
: o	: 111	17	54	43	54	44
Zone [210 . 111]						
$m : e$	311 : 210	3	19	19	19	17
$e : s$	210 : 321	3	17	6½	17	1½
: o	: 111	4	39	12	39	14

CHRYSOBERYL FROM ST NICHOLAS AVENUE

In June 1910 the writer received for identification from Mr James J. Manchester, a small specimen which proved to be chrysoberyl from a new locality on Manhattan island. The specimen in question was collected by Mr Manchester from a building excavation at the corner of St Nicholas avenue and 164th street. It consists of a single small transparent crystal of chrysoberyl embedded in Manhattan schist. The crystal, which is shown in figure 5, measures 5 mm by 8 mm, is light yellowish green in color and is so embedded that about one-half of the prismatic zone is exposed. On the partly exposed end traces of terminating planes were noted, but these were so rough and indefinite that no terminating forms could be identified. Measurements in the prismatic zone showed the presence of the following forms: $a(100)$, $b(010)$, $t^*(11.3.0)$, $m(110)$, $s(120)$, $g^*(370)$ and $r(130)$. Of these, t and g are new to the species. Owing to the position of the matrix surrounding the crystal, only one face of each of these new forms could be observed. The planes were narrow and t yielded a fair, and g a rather poor reflection of the goniometer signal. The forms were identified from the following measurements which in every case except that of m corresponded to a single observation; m furnished two readings:

Fig. 5

LETTER	ANGLE	MEASURED		CALCULATED	
$a : t$	100 : 11.3.0	7°	21′	7°	18½′
$: m$	: 110	25	12	25	10½
$: s$	: 120	43	17	43	13½
$: g$	: 370	47	15	47	39½
$: r$	: 130	54	44	54	39½
$: b$	: 010	90	2	90	0

PYROXENE FROM JEROME PARK RESERVOIR

The material upon which the following note is based was collected in November 1904 by Mr J. H. Adams, from an excavation at the southern end of the Jerome Park Reservoir at Jerome avenue and 205th to 207th streets. A suite of twelve specimens from this find was placed at the writer's disposal for study, through the courtesy of the American Museum of Natural History of New York City, which institution is now the repository of the type specimens.

The minerals occur in a limestone vein in Fordham gneiss, the point of contact being marked by titanite, brownish-green actinolite in flat acicular crystals, albite and pyroxene. The last mineral which occurred on two of the specimens studied consisted of small crystals, the largest measuring 20 mm in length and 2 x 5 mm in cross section, which marked the contact phase, and minute crystals averaging 1 mm in diameter, occurring embedded in the calcite of the vein. The largest crystal of the group is shown in figures 6a and 6b. The forms observed on this crystal are: $c(001)$, $b(010)$, $a(100)$, $f(310)$, $m(110)$, $i(130)$, $e(011)$, $\mathfrak{h}(031)$*, $\sigma(112)$, $\mu(121)$, $R(\bar{1}32)$, $\varepsilon(\bar{1}21)$, $v(\bar{2}11)$, and $\mathfrak{l}(\bar{3}21)$*.

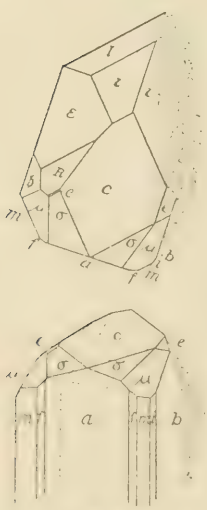

Fig. 6

The forms marked with an asterisk (*) are new to the species. In habit this crystal is characterized by the prominence and brilliancy of the planes of the pyramid $\sigma(112)$, a comparatively rare form for pyroxene. The new clinodome $\mathfrak{h}(031)$ was observed only once on this crystal, partly due to the fact that only one termination was exposed. The face noted, however, gave a fair image of the signal, fell well in zone with the basal and clinopinacoids and showed a close correspondence between measured and calculated angles. The new pyramid $\mathfrak{l}(321)$ was observed from one well-developed plane

at the intersection of the zones [110. $\bar{2}\bar{1}1$] and [100. $\bar{1}\bar{2}1$], both of which zones are well marked. The face gave fair images of the signal, fell well in the zones indicated and showed a close agreement between measured and calculated angles in these zones. The form was also found on two of the smaller crystals measured. Four of the smaller crystals referred to above were measured. These were found to be of a slightly different type as shown in figure 7, which gives three projections of one of these minute crystals. The following forms were observed: $c(001)$, $b(010)$, $a(110)$, $f(310)$, $m(\bar{1}10)$, $i(130)$, $e(011)$, $y(101)$, $w(111)$, $\sigma(112)$, $\mu(121)$, $R(\bar{1}32)$, $\varepsilon(\bar{1}21)$, $\sigma(\bar{2}11)$ and $\mathfrak{l}(\bar{3}21)$*.

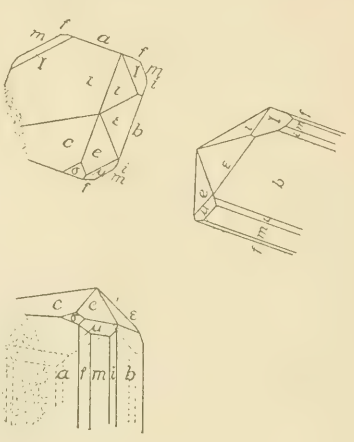

Fig. 7

The forms of this and the preceding types were identified by the following measurements:

LETTER	ANGLE	NO.	MEASURED		CALCULATED	
$b : i$	010 : 130	3	17°	$35\frac{1}{3}'$	17°	35′
$: m$	: 110	16	43	$32\frac{1}{2}$	43	33
$: f$	: 130	7	70	37	70	41
$c : e$	001 : 011	2	29	28	29	33
$m : e$	110 : 011	2	58	$30\frac{1}{2}$	58	$35\frac{1}{2}$
$c : \mathfrak{h}$	001 : 031	1	59	36	59	33
$y : u$	101 : 111	2	24	$14\frac{1}{2}$	24	15
$b : u$	010 : 111	2	65	43	65	45
$\sigma : \sigma'$	112 : $1\bar{1}2$	1	28	45	28	48
$m : \sigma'$	110 : $1\bar{1}2$	2	81	$37\frac{1}{2}$	81	$30\frac{1}{2}$
$c : \mu$	001 : 121	1	47	20	47	23
$a : \mu$	100 : 121	2	61	37	61	$21\frac{1}{2}$
$m : \mu$	110 : 121	3	35	16	35	$23\frac{1}{2}$
$c : R$	001 : $\bar{1}32$	1	43	50	43	57
$m' : R$	$\bar{1}10$: $\bar{1}32$	2	61	21	61	$25\frac{1}{2}$
$c : \varepsilon$	001 : $\bar{1}21$	1	55	33	55	38
$a' : \varepsilon$	$\bar{1}00$: $\bar{1}21$	2	79	37	79	$51\frac{1}{2}$
$b : \varepsilon$	010 : $\bar{1}21$	2	41	$28\frac{1}{2}$	41	21
$m' : \varepsilon$	$\bar{1}10$: $\bar{1}21$	2	48	20	48	17
$a' : \tau$	$\bar{1}00$: $\bar{2}11$	1	54	4	54	13
$b : \tau$	010 : $\bar{2}11$	3	65	48	65	41
$m : \tau$	$\bar{1}10$: $\bar{2}11$	3	45	19	45	28
$a' : \mathfrak{l}$	$\bar{1}00$: $\bar{3}21$	2	47	48	47	50
$b : \mathfrak{l}$	010 : $\bar{3}21$	2	55	40	55	31
$m' : \mathfrak{l}$	$\bar{1}10$: $\bar{3}21$	2	29	$12\frac{1}{2}$	29	19

THE MICMAC TERCENTENARY

By John M. Clarke

Recent years have given us a freshet of historic anniversaries. We are swinging through lustra laden with memories of events which subtend large angles in our destinies. We are not to be allowed to forget these, the crucibles in which we were refined. But amid these larger occasions, now and again some event of lesser note in our records strikes its anniversary, graciously salutes its own community or its beneficiaries and takes up again its little orbit.

It is one of these seemingly minor commemorations, now no longer new and so perhaps no longer news, to which, as an interested participant, I desire to refer before the event passes too far out of reach: the Micmac Tercentenary, held at Ristigouche, Province of Quebec, June 24, 1910. It has not received the public notice to which it is entitled and the occasion to remind ourselves of its significance should not be idly let pass.[1]

The date was not haphazard, nor was the place. On June 24, 1610, Membertou, grand chief of the tribe of Micmac Indians, with twenty-one of his people, was baptized into the faith by Father Jesse Fleché at Port Royal (Annapolis, Nova Scotia); on June 24, 1910, at the Capuchin mission on the Micmac reservation at Ristigouche, by the invitation of the Reverend Father Pacifique, special missioner to these Indians, chiefs, councilors and captains of the tribe, with many high dignitaries of the church, assembled to commemorate this ancient event and most momentous occurrence in the history of these people. The reverend priest who organized this successful commemoration kept in the foreground its spiritual significance. The occasion was largely a religious one but still one fraught with very real historical and ethnological significance.

The event which this interesting celebration commemorated was not one that excited in its day much comment or notice from contemporary historians. We know from a few records little else than the simple fact stated above. It may be found in Lescarbot's

[1] The writer attended this interesting fête as a delegate from the Education Department and the New York State Historical Association.

Relation Dernière and in a letter addressed by an eye witness named Bertrand to the Sieur de la Tronchaie.[1]

We need not take this occasion to review Parkman's rather austere and injudicial portrayal of Poutrincourt's zealous efforts to bring the aged Chief Membertou and his tribe into the church. The deed was done in fervor; whether it was done to anticipate the Jesuits in the same field, matters little now. The baptism at Port Royal stands as the achievement of a conviction supported by resolution, the combination that has always done things that are worth while. The old chief, having given his adherence to the new religion, instilled his faith into all his tribe, perhaps whether they liked it or not, until all the Micmacs under his control had surrendered fully to the new religion. And thus at Annapolis began the spiritual regeneration of the tribe till, under the labors of the "Black-robes" and the "Bare-feet" alike, it extended throughout the entire domain of the Micmacs in Acadia and Gaspesia. However historians, in the conventual repose of their libraries, may construe the initial effort, the seed was planted and the occasion of June 1910 showed something of the harvest.

There was a far deeper meaning to this event — one which it was not the purpose of the tercentenary to commemorate and was obviously omitted, but it has stamped an elemental influence on the history of this western continent. The Micmacs were the first of the American Indians to surrender to the white man's religion.

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[1] The latter is quoted by R. F. Pacifique in a souvenir brochure issued in advance of the tercentennial: "Une Tribu privilegiée" — an illuminating and erudite history of the tribe and a sympathetic analysis of the Micmac psychology. This pamphlet is itself an important historical document, for its author is, of all men, he who doubtless knows the Micmac people best, has sojourned with them most, has received their confidences, soothed their anxieties, advised them in their spiritual and secular interests oftenest. For them he has printed prayer books, hymnaries and catechisms in their own language and today issues a monthly journal, "Le Messager Micmac," in their tongue. Thus incidentally to his spiritual labors he has rendered a great service to philology and linguistics in helping to conserve this Souriquois language. It is surely upon this learned and devout Franciscan that the mantle of his confrère, LeClercq, the intrepid missioner to the "Savages" in the Gaspé peninsula in the 1600's, when the country was wild and they were wilder, has fallen. He has succeeded to the labors of the devoted Biard and Maillard. To the publication we have referred and to his later "Souvenir" of the tercentenary, the writer (or indeed any writer on this theme) must perforce be attentive and from them a constant borrower.

That meant a bond offensive and defensive with the Frenchman who had instilled the new faith. If by the chance of adventure, of geography or of discovery these Indians had been Iroquois instead of the bitterest enemies of that great Confederacy, the whole course of American history would have run in a very different channel. But with the conversion of Membertou and his tribe to the faith of the Frenchman, the die was cast. Mutual and historic enmities alined themselves. The Micmacs first (the Souriquois, as the early French called them), and then in the logical sequence of history the entire Algonquin stock of which they formed a branch, became the allies of the one culture; their enemies, the Iroquois, by very grace of this fact, became the enemies of that culture, and no effort of colonization, of treaty, of conversion (though none was spared) ever could turn the scales the other way. The great Confederacy of the Six Nations, holding the apex of the critical triangle in New York at which converged the St Lawrence pathway of the French and the Hudson-Mohawk pathway of the English, held the balance of power between the two. If we analyze our history down to its roots it is perfectly right to look back on the conversion of Membertou, his squaw, his children, his children's children and his tribe as the first step toward the ultimate supremacy of the English culture in America.

The student of Indian ethnology may look upon the Micmacs as only a little tribe, of small moment in the sum of aboriginal history, but, spread out along the northeastern shores of the Atlantic, they were the first of all American Indians to come in close contact with the whites, and today they are the only Indian tribe in all America that has held its own in numbers; its members are as many as when the Europeans first saw them. In this statement there are, of course, only the estimates of the early missioners, LeClerq and Biard, to guide us, but the fact seems well established. Father LeClercq, laboring in Gaspé, the northern reaches of their hunting grounds where their number was always few, thought in 1680 that his "Gaspesians" numbered no more than 500, but Biard at an earlier date (1611) and nearer the center of their settlements in Acadia, estimated them at 3000 to 3500. In 1871 Hannay in his history of Acadia, placed the number at "nearly 3000" and adds "it is doubtful if their numbers were ever much greater." Dr Dionne, the distinguished historian of Quebec, says that in 1891 the Micmacs numbered 4108; Father Pacifique in 1902 made a personal enumeration of the tribe and placed the number at 3850

in Canada and 200 in Newfoundland. Today according to Father Pacifique and the last official census there are 4319 members of the tribe, of whom only 230 live in Newfoundland and about 15 in the United States.

It is thus very evident that the tribe has been one of extraordinary vitality and has perpetuated itself and even multiplied in the face of much the same conditions which brought about the depopulation of every other aboriginal people of this hemisphere. Some ethnologist with the proper psychological equipment might well seek out the causes of this phenomenon. Evidently somewhere in their composition or their environment, by nature or by grace, there has lain a resistant virtue which other tribes have missed, though both by nature and grace, their lands have not greatly invited the white man's lust.

It is not that these Indians have increased by excessive mixture with the whites. This tendency to intermarriage has never been general among the people nor has it essentially modified their physical type. On the other hand, one can not fail of being impressed with the perfection of the physiognomy and the sturdiness of the physique in all the better men of the tribe. Father Pacifique says:

"It is true there have been many crosses, legitimate and illegitimate, but in a few generations the type will be fully restored. I have observed that the last children of mixed families are less white than the first born. Moreover their attachment to their beautiful language is a guaranty of cohesion and permanence."

The learned father has here noted a Mendelian factor of ultimate force in insuring a stable or aboriginal type from variation, and which is quite sure, in the mixture of races, eventually to dominate the secondary or derived type represented in this case by the whites.

The Micmacs, too, hold to their original soil. Too many of our aborigines have been shifted about, the shuttlecock of the white man's designs, and find themselves today far away from their old hunting grounds. The Micmac country was the extreme orient of the Algonquins, and in the historic confederacy of this Algic stock which once covered half the continent, they were the "youngest brother," their land *Migmagig,* the "country of friendship." The "elder brother" was the Abenaki to the south and west, while the "father tribe" was the Ottawa, their land the "land of their origin."

The tribe is scattered as in the days of Cartier, and spreads through the region over which Nicolas Denys held patent as lieutenant governor in 1658 from "the Cap de Campseaux as far as the Cap des Roziers." There are fifty-six small settlements or reservations scattered all the way from the Gaspé peninsula to Cape Breton, the largest of all being at Ristigouche, the seat of the Capuchin monastery and church of St Ann and the metropolis of the tribe, where they number 506. Their segregation into widely scattered but numerous settlements is unusual in the present disposition of the Indian tribes and might seem to expose them, by the very fact of freer contact with the whites, to variation and change. They speak the French in French communities and the English in English, but for business purposes only. Among themselves their own language alone is spoken and without variations, no matter how wide apart their homes may be. "It is certain that the race is not disappearing either by extinction or by absorption" (F. P.). This fact is all the more noteworthy because these Indians have been in no wise exempt from the curse of alcohol,[1] tuberculosis and syphilis. These evils have played havoc here, as they have and do today elsewhere among the aborigines. It may be that their general poverty (for there is a total absence among them of the occasional prosperity one sees among the other tribes) and their ignorance of hygienic living will eventually make inroads on their vitality which the life out of doors may not be able to combat — and here lies at the hand of their legal guardians and of their white neighbors an immediate duty.

I could not venture to write even in summary the part the Micmac tribe has played in history. It is knit close to the story of early French settlement of Acadia. The enmities of the French were ever its enmities, and this hostility to the English was not based on religious grounds alone. The difference in the attitude of the French and the English toward the Indians is of common knowledge. By the French they were never regarded as subjects of the French king so much as his wards and so by the French clergy they were ever treated not only with gentleness but with

[1] Long ago Denys painted in vivid colors the fearful effects of the Frenchman's liquor on these savages. For this, in those days of the 1600's, they spent their very lives; all the spoils of the winter's hunt were exchanged for liquor and the summer was one long debauch till the fishermen sailed away from the coast. All this has passed and yet today with them, as with all the aborigines, firewater makes the Indian into a savage again and brings out to the surface all that religion has helped to bury.

prudence. The French missioners found them in their simple-minded naturalness and though their spiritual labors were slow of fruitage,[1] the hardship was intensely magnified by the incursions of the English. One who would realize this may well read the account given by LeClercq of the burning of his churches and missions by the "Bastonnais" (Phips). So through the early history of Acadia they were friendly neighbors to the French, and with the English conquest they submitted, not without some hesitation, to the changed régime, and made their allegiance to the new sovereign. When the American war came on efforts were made through the King of France to induce them to revolt against the English, but the advances of Count d'Estaing and Commander Preble were sternly rejected in forcible terms.[2]

Today they are loyal and the most ancient of all Canadians.

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[1] LeClercq in Gaspé more than once speaks of the discouragements of his task and finally begged of his superior to be relieved of further efforts to convert the Gaspesians.

[2] Chief Jerome of Ristigouche exhibited on the occasion of the tercentenary a copy of a "Declaration au nom du roi, a tous les anciens Francais de l'Amerique Septentrionale" printed on board the *Languedoc* in Boston harbor October 18, 1778. At the bottom of the first page is written by hand: "A mon cher Frère Joseph Claude et autres sauvages Mickmacks. De la part de Monsieur le Comte d'Estaing, Vice-Amiral de France, Holker, agent general de la marine et consul de la Nation francaise."

With the rest of the settlers of the St Lawrence coasts, the Micmacs had learned to dread the repeated invasions throughout the old régime, which took their start from Boston. The "Bastonnais" were well hated and not a little feared, so that in time the term became of common application to all the English. I think the term is not quite extinct — at any rate I have heard a French fisherman call a rather disagreeable American tourist in Gaspé a *Bastonnais,* with all the old feeling that the epithet must once have carried. Even yet, to the Micmac, the States is the country of the *Bastonnais,* and on his map of the world the whole area of the United States is called "Poston." Thus the evil that men do lives after them and Boston is by merit raised to this eminence.

The ancient traditionary fears of the gentle-minded Micmac had a curious illustration on the occasion of the tercentenary. While the Indians were gathered in the church for the opening ceremony on the morning of the first of the three days, some mischievous miscreant circulated the story that their old enemies the Iroquois, having heard of this assemblage, were lying in the woods outside ready to take advantage of their helpless state and fall upon them. After the mass and the sermon by the missionary, there appeared a growing restiveness among some of the Indians, whispers and awed looks spread through the pews, and these were not wholly dispelled till the wise and patriarchal Grand Chief had assured his people that such a story could only be the invention of the father of lies.

The interesting commemoration gives rise, in my mind, to reflections on a well-worn and ever present theme — the attitude of the white master toward the Indian. Perhaps as a titular official of the Iroquois League the writer may have had opportunity to acquire a right to this expression: There is one perfectly evident inference from the apparent motives and the actual dealings of the French and English cultures with their red allies, whether expressed in provincial, state or federal attitude; the French would ever let the red man be a red man; the English would make the red man into a white man. That is the situation succinctly stated. It would be just to go further and put the statement thus: that Canada would let the red man develop along lines of least resistance, while America has ever insisted and is still insisting on at once turning the red man white. The problem has worked its way along further in the older east than in the newer west.

I fancy we may not ascribe to the founders of our governments on either side the line any profound recognition of natural law, but it has certainly so happened that French Canada and French influences in Canada have been content to grant the fundamental difference in culture and to leave the Indian to come up slowly from his barbaric state under a spiritual rather than a civic impetus. It is thus the natural law works — slowly, if effectively. A great abyss in nature, profoundly divergent lines of culture meeting at their start but standing wide apart at the extremes, can not be jumped by legislative enactment. Lines of racial development, one following far behind the other, can not be brought together by the process of legislative stretching. The law that says red is white has either a fool or a knave for its author. Just as little can great monetary foundations designed to effect immediate alterations in the slow but orderly procedure of natural law — such as the development of language or the establishment of universal peace — escape the conditions which that law imposes. The supremacy of a law which lies above the statute and the common law is a fact which statute makers and statesmen have been slow to learn; experience is full witness to this. The English attitude toward the American Indian has never once suggested the concession that the Indian has just as much right on this earth as he, and has played just as significant a part in human progress. To the English colonists and the ideas they have left alive, the red man is a potential citizen as soon as he can be forced to measure up to

certain more or less artificial conditions of education and deportment.[1]

French Canada assumed from the outset that the gap between the Indian and the Frenchman was the chasm between a primitive and advanced culture which only the slow process of time could bridge — it seemed to recall the ages which had been necessary for the Frenchman himself to come up from a like aboriginal condition. At any rate what the Catholic pioneers of New France saw in the Indian and what their successors still see is that the Indian has a soul to save. To bring him to adjust his natural religion to the more adequate conceptions of Catholicism was the purpose of the majestic and sublime sacrifices which so brilliantly illumine the pages of the old régime. No judicial mind can contemplate the results of Catholic and Protestant missionary endeavor among the American Indians and avoid the conclusion that the Catholic Indians have on the whole preserved their physical aboriginal type in greater perfection, have kept much of their tribal culture, possess a deeper religious conviction. Among the Protestant Indians there are many instances of individual attainment of noteworthy excellence in education, public usefulness and personal uprightness, but it is perfectly evident that the term Protestant as applied in some of the Indian tribes does not mean Christianized, so much as it implies an avowal and allegiance to a given form of religious worship, and in many cases, little else. My own personal observation is restricted to neither class, and I believe there is good reason for saying that, broadly, in matters of faith the Catholic Indian is a Catholic while the Protestant Indian is an Indian. It is an important fact in its historical bearings that the tribes which have been subjected to the most direct and persistent Protestant effort have never fully surrendered their natural religion. Indeed among the Iroquois of New York and Canada there are two very distinct interests in the League represented by the "Christians" and the "pagans."[2] So far as my knowledge goes, this is not at all the condition among tribes acknowledging allegiance to the Catholic church.

[1] In the condition of the Six Nations Indians in Canada and New York, there is a contrast, either creditable to the one government or discreditable to the other. Canada has let its Iroquois work out their own salvation and these Indians today are well educated, energetic, aggressive and fairly prosperous. In New York the reports of 1910 show that more than one-third (35.5 per cent) are illiterate.

[2] The Canadian Oneidas have now gone back to paganism after years of Protestant missionary labors.

We have already said that the conversion of the Micmacs was an elemental and influential factor in the historic conflict of English and French cultures on this continent. We are not likely to exaggerate its importance, whichever way the tides of events turned. It would be unfair and historically inaccurate to say that the influence of the Grand Chief Membertou on the Micmac tribe, allied with the efforts of the devoted French missioners, finds its counterpoise in the single personal hold of Sir William Johnson who by force of his own personality kept back the Iroquois from alliance with the French. The two opposed facts are of different magnitude and unlike in quality, but similar in their antagonistic effect. Let us give to this historic event of 1610 all its true meaning in the century-long struggle between the French and English cultures. That struggle took its final direction in the contest for this continent, and the spectacular victories of Amherst and Hardy and Wolfe were made possible only by the strong hand of His British Majesty's Indian Agent, which held back the Iroquois from the French interests.

THE MANHATTAN INDIANS

BY ALANSON SKINNER

INTRODUCTORY

Some time before the advent of the Dutch at New Amsterdam, a branch of the Lenni Lenapé or Delaware Indians split off from the parent stock, which had its abode south and west of the Hudson and moved eastward and northward forming the Mahikan tribe. They occupied Manhattan island and the east bank of the Hudson as far north as the southern boundary of the Mohawk Iroquois. In time they became subdivided into several subtribes and bands, the chief of which, known as the Wappinger Confederacy, was composed of the Wappinger, Kitchawanck, Sintsinck, Siwanoy, Weckquaesgeck and Reckgawawanck. Of these people the two tribes last mentioned were found by the Dutch inhabiting Manhattan island. At that time the Weckquaesgecks held the upper part of the island above a line drawn from the Rechewa's creek (later Harlem creek) to the ravine at what is now Manhattanville, and the Reckgawawanck occupied the lower part of the island. Both of these tribes also held territories on the mainland where their principal abodes were situated. The name Manhattan referred to the portions of both tribes dwelling on the island and it is said to mean "Islanders." Although the modern Delawares insist on translating "Manhattanink" as "The Place Where They Were All Intoxicated," basing the name on the traditions of their first meeting with the whites and their introduction to spirituous liquors.

All the old records claim that Manhattan island was used not as a permanent abode but as a hunting and camping ground, assertions which, however true at the time of the Dutch occupation, do not seem entirely to hold good of the prehistoric period.

Our first records of the Manhattan Indians or their kindred date from Verrazano in 1524, and we have little further information in regard to them until 1609 when Hudson entered New York harbor. The first account of the Indians of the neighborhood of New Amsterdam is also by Verrazano[1] who said that they did not differ much from the natives whom he had met elsewhere along the coast and that they were of good proportions, medium height, deep chested and strong armed. He met among others "two kings more

[1] Collection of the New York Historical Society, 2d series, 1:45.

beautiful in form and stature than can possibly be described; one was about forty years old, the other about twenty-four." They were dressed in the following manner:

"The oldest had a deer's skin around his body, artificially wrought in damask figures, his head was without covering, his hair was tied back in various knots, around his neck he wore a large chain ornamented with many stones of various colors. The young man was similar in his general appearance." In stature, he relates "they exceed us," their complexion swarthy, faces sharp, hair black and long, eyes black and sharp and expression pleasant and mild. The women were "of the same form and beauty, very graceful, of fine countenance, and pleasing appearance in manners and modesty." Clothes they had none "except a deer skin ornamented like those of the men." Others wore "very rich lynx skins upon their arms, and various ornaments upon their heads, composed of braids of hair which hung down upon their breasts on each side. Older married men and women "wore many ornaments in their ears, hanging down in the oriental manner." They were generous, giving away whatever they had. The women usually stayed in the canoes when they came to the ship.

Our next data in regard to the personal appearance of the natives of old New Amsterdam is in Hudson's mate's journal written in 1609: "The people of the country [perhaps Staten island] came aboard of us, seeming very glad of our coming, and brought greene tobacco, and gave us of it for knives and beads. They goe in deere skins loose, well dressed. They have yellow copper. They desire cloathes, and are very civill. They have great store of maize or Indian wheat, whereof they make good bread. . . . Some of the people were in mantles of feathers, and some in skinnes of divers sorts of good furres. Some women also came to us with hempe. They did weare about their neckes things of red copper. At night, they went on land againe, so wee rode very quiet, but durst not trust them."

The next day after Hudson dropped anchor in the Lower bay, he sent out the ship's boat with a crew of five men through the Narrows to the Upper bay to make some observations. As they returned, they were met by a score or more of warriors in two canoes and were speedily drawn into a quarrel with them. One sailor, an Englishman named John Colman, was killed by an arrow shot through his neck and two others were hurt. Colman was afterwards buried at a point usually identified as Sandy Hook, which for many

years bore his name. Some local historians, in writing concerning Staten island, have placed the scene of Colman's death at the locality now known as the Cove, in West New Brighton, Staten island, but there is little evidence to confirm this.

At a later date Van der Donck stated the young warriors wore "a band about their heads, manufactured and braided, of scarlet deer hair, interwoven with soft shiny red hair," perhaps very much like the deer's hair head dresses worn today by the Sauk and Fox, Sioux and other modern tribes, "with this head dress they appear like the delineations and paintings of the Catholic saints. . . . When a young Indian is dressed this way he would not say *plum* for a bushel of plums. But this decoration is seldom worn unless they have a young woman in view."

"The women wear a cloth around their bodies, fastened by a girdle, which extends below their knees, and is as much as an undercoat; they wear a dressed deer skin coat, girt around the waist. The lower body of this skirt, they ornament with great art, and nestle the same with strips which are tastefully decorated with wampum. The wampum with which one of these skirts is ornamented is frequently worth from one to three hundred guilders. They bind their hair behind in a club about a hand long, in the form of a beaver's tail, over which they draw a square cap, which is frequently ornamented with wampum. When they desire to be fine they draw a head band around the forehead which is also ornamented with wampum, etc. This band confines the hair smooth, and is fastened behind over the club, in a beau's knot. Their head dress forms a handsome and lively appearance. Around their necks they wear various ornaments, which are also decorated with wampum. Those they esteem as highly as our ladies do their pearl necklaces. They also wear hand bands or bracelets curiously wrought, and interwoven with wampum. Their breasts appear about half covered with an elegantly wrought dress. They wear beautiful girdles, ornamented with their favorite wampum, and costly ornaments in their ears. Here and there, they lay upon their faces black spots of paint. Elk hide moccasins they wore before the Dutch came, and they too were most richly ornamented."

Van der Donck states that chiefs or men of wealth and importance had a plurality of wives, but that this was not the rule. Chastity seems to have been considered a virtue, and was much more common in this immediate vicinity than among the Algonkin of the north.

Enough has been here stated to give a general idea of the personal appearance of the Indians about Fort Amsterdam at their first meet-

ing with the white men and at a later date. Their ethnology has been more fully described elsewhere.[1]

As Hudson journeyed northward up the river which now bears his name, he had many experiences with the natives, some friendly, others warlike. On the return trip he tried to kidnap two young warriors from an Indian village, but both of his intended victims escaped and jeered at their would-be kidnaper, and one of them shortly returned at the head of a band of his friends in a swarm of canoes. As they were not allowed to board the "Half Moon" which was well under way, they fell behind and sent a storm of arrows in her direction. Six musket shots from the ship killed two or three of the warriors, and discouraged the rest, who retreated to a point of land whence they returned to the attack, but a cannon shot killing two of them drove the rest to the forest. Still undaunted, another war canoe set out, manned by nine or ten men, which was promptly sunk by a cannon shot, and a volley from the muskets of the sailors destroyed three or four more, and the unequal battle being terminated in triumph, the victors set their sails for home. This entire scene is supposed to have taken place at Inwood and about the mouth of Spuyten Duyvil creek. At the former place especially, traces of Indian settlements are still to be found. Thus ended the first chapter of the dealings of the Manhattan with the whites, a fitting prelude to the scenes soon to be enacted.

During the next four years white men were more frequently seen on Manhattan island and by 1613 the Dutch were firmly established at Fort Amsterdam. As they progressed up the Hudson river the new-comers soon learned that all the Algonkins in the vicinity were in deadly terror of the Five Nations of the Iroquois, especially the most eastern tribe, the Kanienga, or as the River Indians termed them, "Maquas or Bears, (a name probably suggested by one of the most powerful of their three clans, and from which our word Mohawk is derived).

These ferocious warriors had contracted through a deadly hatred of the French the mistaken policy of Champlain at whose hands they had suffered defeat some nine years before near what is now Ticonderoga, and they hailed the advent of the Dutch with delight, perceiving at once that here lay their opportunity to obtain the firearms they needed to triumph over their neighbors and enable them to be revenged upon the French.

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[1] Skinner. The Lenape Indians of Staten Island. Anthropological Papers, v. III, p. 3.

The Dutch, on the other hand, soon recognized that the Five Nations would be a powerful ally in case war broke out among the Indians about Fort Amsterdam, and so in 1618, in the Tawasentha valley, the famous offensive and defensive alliance between the Dutch and the Iroquois was formed, an alliance kept up at a later date by the English, and which resulted in the downfall of France in the New World, through the untiring agency of this resolute group of American savages, but it was an evil day for the Manhattan when the treaty was made with their most powerful and deadly enemies.

In 1626 the entire island of Manhattan, about 22,000 acres in all, was purchased by Peter Minuet, then governor, for 60 guilders worth of trinkets. Twenty-four dollars is the amount which is usually rendered as the equivalent of this sum, but as the value of gold was then five times greater than at present, it amounted to some one hundred and twenty dollars, a liberal sum compared with many Indian purchases of those days. However, according to the old accounts, the Indians considered the island as being divided into two parts, the upper half above the Harlem creek remaining unsold.

From the first the dealings of the Manhattan and the Dutch seem to have been fraught with treachery and violence on both sides. While Minuet himself appears to have been open minded and just, his subjects were not all of the same calibre, and the seeds of war were sown daily in the bosoms of the Indians.

In 1626, the same year that the purchase of Manhattan island took place, a Weckquaesgeck Indian from the vicinity of Yonkers, accompanied by his nephew, who was only a small boy was bearing his furs to the fort to trade when they were waylaid and robbed by some servants of Minuet himself. The Weckquaesgeck was murdered before the eyes of the child, who escaped bearing with him a memory of violence which, according to Indian ideas, could only be erased by blood.

Continual aggressions by the Dutch caused endless friction with the savages. Lands were fraudulently acquired, cattle belonging to the whites trespassed on the Indians' corn fields unchecked, and when the natives took the law in their own hands and slew them, reprisals were in order. So affairs went from bad to worse, intolerance and discord growing on either side.

During the misadministration of Governor Kieft, that worthy decided to tax the Indians to compensate for what he considered their constant misdemeanors and to establish a firm hold over them, and he went so far as to send an armed sloop to the Tappan to

collect this tribute in corn and wampum, but the Indians scornfully refused to pay and made sarcastic speeches about the Governor.

The following year, 1640, some of the Dutch West India Company's servants stole some hogs from De Vries's plantation on Staten island, and Kieft, wishing for a pretext to rid himself of a few of his Indian neighbors, blamed it on the Raritans and sent his secretary, Van Tienhoven, in charge of twenty men to punish the Indians for their alleged theft. The party went to a spot located, according to De Vries, somewhere behind Staten island, probably on the New Jersey shore. When the destination was reached the men became insubordinate and decided, against the earnest appeal of the secretary, to murder every Indian they could. At last Van Tienhoven left them in despair and proceeding but a short distance they came to the Indian settlement where wigwams and crops were burned and a number of Indians killed, including the brother of the chief, who was atrociously murdered after he had been made prisoner by one Govert Lockermans (De Vries in his Journal says this man was not killed but outrageously maltreated). They then withdrew, leaving one of their number dead upon the field of victory. As a result the plantation of David Pietersz De Vries on Staten island, was promptly attacked by the angry natives, four of his planters were killed and his tobacco and dwelling houses destroyed. After a time this trouble blew over but more friction was at hand.

Claes Smit, a Dutchman, was approached one day by a young warrior who offered him some beaver skins to trade. Smit went to comply when the Indian tomahawked him, plundered the house and escaped. It was the young Weckquaesgeck, who, according to Indian ideas, had avenged the murder of his uncle so long before. Kieft demanded the murderer, but was refused by his tribesmen. Kieft then called a general council and laid the matter before it, suggesting that in case the murderer were not forthcoming, his whole village might be destroyed. The council referred the matter to the "twelve select men," who wisely suggested that quiet preparations for hostilities might be carried on in secret, and that in the meanwhile a sloop be sent to the Weckquaesgecks to demand the murderer, "once, twice, yea for a third time" in a friendly manner.

About this time Miantonimo, the chieftain of "Sloops," or as it is now called, Narragansett bay, visited the Manhattan and other local Indians in order to get their alliance in a controversy pending with the Mohegan. This threw the Dutch into confusion for a time, as he was suspected and accused of stirring the Indians up against them, but at length the scare blew over. Immediately following

this a Hackensack Indian was made intoxicated and robbed by the Dutch and, in spite of the friendly efforts of De Vries, who met and tried to quiet him, he was so enraged that he murdered a settler in Myndert Mynderssen Van der Horst's colony near Achter Cul or Newark Bay.

This was an unfortunate happening as neither the Hackensack nor Tappan had been embroiled with the Dutch before. The Indians were not in sympathy with the act and at once offered the director, Kieft, through De Vries, two hundred fathoms of wampum to be given to the family of the victim to compensate the crime, as was their custom. This Kieft refused and at length the chiefs visited the fort at the intercession of DeVries, whom they trusted, and who became responsible for their return, and there they repeated their offer. Kieft demanded the murderer and refused the wampum. The Indians could not produce the culprit as he had fled to the Tankitekes or Haverstraws, and moreover he was a chief's son and could not be surrendered. They once more renewed their offer of payment which was refused and they returned uneasily, while Kieft bided his time which shortly arrived.

In February 1643 a band of Mahican armed with muskets came from the upper Hudson below Albany and made a raid on the tribes about Fort Amsterdam, driving them in terror to the Dutch for protection after killing seventeen of their number and taking some of their women and children prisoners. The Dutch sheltered and fed the fugitives and after two weeks they returned to their homes, but a second alarm drove them again to the Fort and to Vriesendael (De Vries settlement). De Vries helped them as much as he was able and begged Kieft for soldiers to assist them, but these were refused. The Indians then congregated at Pavonia among the Hackensack "full a thousand strong," and others at Richtauck (Corlear's hook on East river, not far from the site of Grand Street ferry) where they occupied some cabins erected by the Reckawancks.

The majority of the Dutch, under the lead of De Vries, believed that this was their opportunity to treat the Indians with kindness and so win them over. Kieft, however, in his usual hot-headed and blood-thirsty manner, saw otherwise and decided to do a deed which has rarely been equalled for cruelty and treachery. At midnight Sergeant Rodolf was sent among the sleeping and unsuspecting Indians at Pavonia where he murdered eighty of them in the most brutal manner, and soldiers under Maryn Adriansen massacred forty more at Corlear's Hook. De Vries has left us a manuscript in which he describes the entire outrage, to which he was an eye witness, in scathing terms.

When the Indians learned it was not the Mahican (or as they had supposed, the Mohawk) but the director that they had to thank for their inhospitable entertainment, eleven tribes took the war path. Farmers and settlers outside the immediate walls of the fort were killed on every hand, and the Dutch were terrified.

Even Vriesendael was attacked and partially destroyed. De Vries and his people were fortunately able to escape to the fortified manor house where they awaited the assault, when an Indian whom De Vries had managed to save from the massacre appeared and told the assembled warriors that De Vries was " a good chief " persuaded them to desist. This they did with protestations of regret that they had slain his cattle and burned the houses, and though they wished very much to have the copper kettle in the little brewery to make arrowpoints, they left it where it was and withdrew regretting that they had injured their friend.

The Dutch fled to the fort for protection and were loud in their complaints against Kieft, who met them defiantly at first and blamed the calamity on Adriansen, one of his councillors, who promptly sought to vindicate his honor by slaying the governor, an attempt in which he unhappily failed. At last, according to the old documents, terror reduced Kieft and his people to begging from God the mercy which they had not granted the Indians that night at Corlears Hook and Pavonia.

Toward spring the savage warriors began to relent, the Long Island Indians sending three men from the wigwams of their chief Penhawitz to open negotiations, from whence De Vries and a man named Albertson, the only settlers who were not afraid to go, accompanied them back to their village. Setting out on the 4th of March they arrived at Rechquaackie or Rockaway where they found Penhawitz and nearly three hundred warriors at a village of thirty lodges. " Next day," says De Vries, " we were awakened and led by one of the Indians upwards of 400 paces from the route where we found sixteen chiefs from Long Island who placed themselves in a circle around us. One of them had a bundle of small sticks. He was the best speaker and commenced his speech. He related that when we first arrived on their shores, we were sometimes in want of food, they gave us their beans and corn, and let us eat oysters and fish, and now for recompense we murdered their people. He here laid down one little stick, this was one point of accusation. The men whom in your first trips you left here to barter your goods till your return, these men have been treated by us as we would have done by our eye-balls. We gave them our daughters for

wives, by whom they had children. There are now several Indians, who came from the blood of the Swannekins (Dutch) and that of the Indians; and these, their own blood, were now murdered in such villainous manner. He laid down another stick." [1]

De Vries invited the chiefs to the fort and eighteen of them went with him in a large canoe to visit Kieft. They received presents and assurances, and at length on the 25th of March peace was arranged. Through the efforts of the Long Island Indians, peace was also concluded on the 22d of April with the Hackensack, Tappan, Reckawawanc, Kitchawanc and Sint-sinck. The presents given to the Indians were meager, however, and the Hackensack especially complained of their insufficiency. During the summer their Sachem warned De Vries that his young men were preparing for the war path, but Kieft gave the chief an insolent message and refused to pacify him with further gifts.

When difficulties again began in New England, in 1643, the Indians took up the hatchet as had been predicted. The trouble was begun by the Wappinger, who seized a boat coming from Fort Orange, killing two men and capturing four hundred beaver skins. Kieft called a committee of eight to consult on this and other outrages, but before a decision was reached, the Weckquaesgeck destroyed Anne Hutchinson's settlement at Pelham Bay and killed that noted woman and captured her youngest daughter, a child of eight years, who was given up to the Dutch at the fort four years later, when she had forgotten her native tongue.

Throgmorton's settlement at Throg's Neck was next destroyed, but here the inhabitants escaped in their boats. Pavonia was burned under the guns of two warships and a privateer, and outside the very fort itself, Manhattan island lay in embers and ashes. "They rove continually around day and night on the island of Manhattan, slaying our folks not a thousand paces from the fort." (Col. Hist. 1:216, 211.) At this juncture, De Vries was obliged to return to Holland, and left calling the vengeance of God upon Kieft's head as the author of so much misery and bloodshed.

Kieft now begged aid from New England, offering twenty-five thousand guilders for one hundred and fifty men, and even offered to mortgage New Netherlands to the English for aid; at the same time beseeching Holland for relief.

He received, however, only a few English volunteers under the command of Captain John Underhill, who was a combination of

[1] De Vries. New York Historical Society Collections, 2d series, 1: 231.

bravery, piety and fiendish cruelty hard to equal. Of the conduct of this genial gentleman in the New England wars, Trumbull has said, "He could justify putting the weak and defenceless to death, for says he, 'The Scripture declareth women and children must perish with their parents . . . we had sufficient light from the word of God for our proceedings.'"

Two companies were soon organized, one of sixty-five men and the other of seventy-five men. The second company was composed of forty burghers under Captain Pietersen and thirty-five English under Lieutenant Baxter, Councillor La Montagne acting as general. This band made a raid upon the Staten Island Indians, but succeeded only in obtaining some corn which had been abandoned. Returning to the fort they were reinforced by one hundred twenty men and invaded the Weckquaesgeck country. They landed at Greenwich, marched all night and found nothing. As they retreated through Stamford they met some English who told them there were Indians nearby. Scouts located an Indian village and twenty-five soldiers sent there killed a number and took some prisoners. Guided by a captive they located three empty Weckquaesgeck "castles" and burned them, after which they returned.

Meanwhile Underhill landed on Long Island and set out to attack the Canarsies under Penhawitz. After landing, Captain Pieter Cock and General La Montagne set out with eighty men to destroy a large settlement at Maspeth and Underhill while fourteen men were sent to a small village or camp at Hempstead. Both parties were successful, killing one hundred twenty Indians, only one of the whites being killed and three wounded.

The English minister Fordham had seven Indians accused of pig stealing locked in his cellar. Three of these Underhill himself killed, two were towed in the water until they were dead, and two were taken to Fort Amsterdam where they were turned over to the soldiers to amuse themselves with.

"The first of these savages having received a frightful wound, desired them to permit him to dance what is called the kinte-kaye, a religious use observed among them before death; he received, however, so many wounds that he dropped down dead. The soldiers then cut strips from the other's body, beginning at the calves up the back, over the shoulders and down to the knee. While this was going forward Director Kieft and his councillor, Jan de la Montagne, a Frenchman, stood laughing heartily at the fun and rubbing his right arm, so much delight he took in such scenes. He then ordered him to be taken out of the fort, and the soldiers bringing him to the

beaver's path (he dancing the kinte-kaye all the time) threw him down, cut off his partes genitales, thrust them into his mouth while still alive, and at last, placing him on a mill stone, cut off his head. . . . . There stood at the same time some twenty-four or twenty-five female savages, who had been taken prisoners and when they saw this bloody spectacle, they held up their arms, struck their mouths, and in their language exclaimed, 'For shame! for shame! such unheard of cruelty was never known among us.'" [1] Rather a heavy punishment for alleged hog stealing.

And now Underhill planned a crowning achievement. Visiting Stamford, he learned that the natives had assembled to a large number. With one hundred forty men, piloted by a renegade Indian, he landed at Greenwich where a heavy blizzard compelled him to remain all night. In the morning he marched to the northwest over stony and steep hills until evening, when he arrived within three miles of the village. Here he waited till ten o'clock and then advanced, reaching the Indian stronghold at midnight. The Indians were all alert and awake, so the whites divided into small bands and attacked the lodges. In a short time one hundred eighty warriors lay dead outside; the rest were cooped up in the houses. At La Montagne's suggestion these were fired. The savages tried every means to escape but when they could not, preferred the flames to falling into the hands of Underhill and his Christian followers. About seven hundred of the enemy, including twenty-five visiting Wappingers, were burned or shot, and not one woman or child was heard to scream or cry. Underhill, diligently as he searched his Bible, never seems to have seen some passages which might have justified more humane action.

The Sint-sinct, Weckquaesgeck, Nochpeem, Wappinger and others after this calamitous defeat begged for peace, and later the Matinecock of Long Island and the Hackensack and Tappan treated with the Dutch, and the Indian war of 1641–45 was ended.

Sixteen hundred Indians were killed, it is said, and the Dutch exclaimed, "Our fields lie fallow and waste, our dwellings and other buildings are burnt, not a handful can be planted or sown this fall on all the abandoned places. All this through a foolish hankering after war; for it is known to all right thinking men here that these Indians have lived as lambs among us until a few years ago, injuring no one, and affording every assistance." [2]

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[1] Documentary History, IV, 105.

[2] Colonial History, 1:210.

For a time things again assumed a peaceful basis, the Indians coming in to New Amsterdam to trade as of old. However, the Dutch could not resist the temptation to cheat and defraud, nor the Indians to drink, and constant friction resulted.

Stuyvesant, who succeeded Kieft, was a better and more diplomatic man, and was more successful with the native tribes. In 1665, however, war broke out again. Hendrick Van Dyck, ex-schout-fiscal of New Amsterdam, lived at what is now the west side of Broadway, near Bowling Green, next door to Paulus Linderstein Van der Grist. One afternoon in September Van Dyck saw an Indian woman picking peaches in his orchard, and, drawing his pistol, shot her dead. Stuyvesant had by his firm, truthful and just dealings with the Indians held them in peace and almost won their friendship, Van Dyck made an end of this by his cruel stupidity.

No notice was taken of the murder by the authorities despite the repeated complaints of the Indians. A war party of Wappinger was on its way to battle, and the local Indians begged their aid. On the 15th of September early in the morning, before scarcely any one had risen, sixty-four canoes containing five hundred armed warriors landed and scattered themselves through the town, and under the pretext of searching for their hereditary enemies, the Mohawk, forced entrance to the various houses. They offered no one any personal violence, however, and their chiefs even consent to attend a council with the governor where they promised to depart in the evening, some going to Governors island, but when evening arrived they returned, joined by two hundred more armed warriors. Landing at the Battery they went up Broadway to Van Dyck's home and there shot him dead with an arrow. Van der Grist, attempting to assist him, was tomahawked.

At this the Dutch burgher guard attacked the Indians without orders just as they were disembarking, and a sharp battle ensued with loss on both sides. The Indians withdrew to the west side of the river where they destroyed Hoboken and Pavonia, and later the settlement at Staten island. Fully fifty persons were killed and one hundred or more captured, and about eighty thousand dollars worth of damage was done. Stuyvesant was at South River when this outbreak occurred but returned as soon as he learned of the trouble. War parties of Indians were wandering all over Manhattan island and the Dutch were confined to the fort.

Upon Stuyvesant's return fortifications were strengthened and preparations were made to resist an assault, but the Indians were

satisfied. They sent Captain Pos, taken on Staten island, with propositions of ransom, but tired of waiting for his return they sent further word that in two days they would deliver all their prisoners to the Dutch at Paulus Hook. Pos went back and soon brought fourteen prisoners from the Hackensack camp with the report that the Indians desired some powder and ball in exchange. These Stuyvesant sent with two prisoners, a Wappinger and an Esopus, and promised more on the delivery of the rest of the captives.

Pos and two others took this message to the Indians, and brought back twenty-eight more prisoners and the intelligence that twenty others would be restored on the receipt of a ransom of powder and ball. Thirty-five pounds of powder and ten staves of lead which were demanded were sent and the prisoners were released. As Stuyvesant believed his people were at fault, he refused to punish the Indians, to the rage of the settlers. Of this outbreak the Long Island Indians denied any part. Indeed it is said that the war party which landed on Manhattan island was on its way to fight these Long Island tribes, and only stopped to avenge the murder by Van Dyck. Had the band been tactfully treated at the time the entire calamity might have been averted.

From this time on the scene of combat was changed to the Esopus country. The Manhattan, Hackensack, Raritan, and Canarsie seem to have taken little part in these troubles. The English under Richard Nicolls now took possession of Fort Amsterdam, which they called Fort James on September 6, 1664. Treaties were made by the English with all the local Indians and the alliance with the Iroquois was strengthened.

Little further trouble was had with the weakening savages who from this time on are rarely heard of as separate bands. Some became incorporated with the so-called "Schaticooks" who were made up of Indians partly from New England, and these often assisted the Mohawks and English against the French. Their descendants may still be seen on the Housatonic river in Connecticut.[1] Others were incorporated among the Delawares and their descendants are scattered in Canada, Wisconsin and Indian Territory. The name of Manhattan is now only a memory and the people who bore it are lost forever.

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[1] *See* Speck. Anthropological Papers, v. 3, p. 183: "The Mohegan Indians."

AUTHORITIES

Bayles. History of Staten Island.

Beauchamp. Aboriginal Occupation of New York.

Bolton, R. P. The Indians of Washington Heights, Anthropological Papers, 3: 77–109.

Calver, W. L. Personal Notes.

Chenoweth, Alexander. Collections and Notes in Museum.

Clute. History of Staten Island.

Davis, W. T. Personal Notes.

De Vries, David Pieteirz. Journal.

Finch, J. K. Aboriginal Remains on Manhattan Island, Anthropological Papers, 3: 65–73.

Fiske. The Dutch and Quaker Colonies in America, v. 1.

Harrington, M. R. Personal Notes and Manuscripts; *also* The Rock-Shelters of Armonk, New York, Anthropological Papers, 3: 125–38; Ancient Shell Heaps near New York City, Anthropological Papers, 3: 169–79.

Juet. Journal of Hudson's Voyage.

O'Callaghan. Documentary History of New York.

Pepper, George H. Personal Notes.

Ruttenber. Indian Tribes of Hudson's River.

Skinner, Alanson. The Lenapé Indians of Staten Island, Anthropological Papers, 3: 3–62.

Speck, F. G. Notes on the Mohegan and Niantic Indians, Anthropological Papers, 3: 183–210.

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In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

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See first note under Geologist's annual reports.

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9	.25	18 (" 64)	.20	26 (" 147)	.35
10	.35	19 (" 67)	.15	27 (" 155)	.40

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Botanist's annual reports 1867–date.

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The divisions to which bulletins belong are as follows:

1 Zoology
2 Botany
3 Economic Geology
4 Mineralogy
5 Entomology
6 "
7 Economic Geology
8 Botany
9 Zoology
10 Economic Geology
11 "
12 "
13 Entomology
14 Geology
15 Economic Geology
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19 Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 164p. 119pl. map. Nov. 1898. *Out of print.*

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—— Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.
—— The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.
Simpson, G. B. Preliminary Descriptions of New Genera of Paleozoic Rugose Corals.
Loomis, F. B. Siluric Fungi from Western New York.

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4 Peck, C. H. N. Y. Edible Fungi, 1895–99. 106p. 25pl. Nov. 1900. [$1.25]

This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d reports of the State Botanist.

5 Clarke, J. M. & Ruedemann, Rudolf. Guelph Formation and Fauna of New York State. 196p. 21pl. July 1903. $1.50, *cloth.*

6 Clarke, J. M. Naples Fauna in Western New York. 268p. 26pl. map. 1904. $2, *cloth.*

7 Ruedemann, Rudolf. Graptolites of New York. Pt 1 Graptolites of the Lower Beds. 350p. 17pl. Feb 1905. $1.50, *cloth.*

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9 Clarke, J. M. Early Devonic of New York and Eastern North America. Pt 1. 366p. il. 70pl. 5 maps. Mar. 1908. $2.50, *cloth*; Pt 2. 250p. il. 36pl. 4 maps. Sept. 1909. $2, *cloth.*

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Catalogue of the Cabinet of Natural History of the State of New York and of the Historical and Antiquarian Collection annexed thereto. 242p. 8vo. 1853.

Handbooks 1893–date.

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Outlines, history and work of the museum with list of staff 1902.

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Classification of New York Series of Geologic Formations. 32p. 1903. *Out of print.* Revised edition. 96p. 1912. Free.

Geologic maps. Merrill, F. J. H. Economic and Geologic Map of the State of New York; issued as part of Museum Bulletin 15 and 48th Museum Report, v. 1. 59 x 67 cm. 1894. Scale 14 miles to 1 inch. 15c.

—— Map of the State of New York Showing the Location of Quarries of Stone Used for Building and Road Metal. 1897. *Out of print.*

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